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SOME OBSERVATIONS ON THE SINGING BEHAVIOUR OF THE HOOLOCK GIBBON (*HYLOBATES HOOLOCK*)[1]

ELLIOTT H. HAIMOFF[2]

(With five text-figures)

The songs of both wild and captive hoolock gibbons (*Hylobates hoolock*) were analysed. This species is one of only three which produce elaborate duets only, consisting of three sequences : the *introductory* sequence, which is produced only at the beginning of the bout; the *interlude* and *great-call* sequences, which are then produced in alternating succession. There is apparently no sexual dimorphism in the vocal repertoire of the adult pair during the duet, with both sexes producing the same types of sound during all three sequences. Lone females have been observed previously to sing alone, and it was found here that one female in particular may sing the male's contribution to the great-call sequence, as well as her own. These findings indicate that although the general overall structural organization of the duet of this species is similar to most other gibbon species, the lack of sex-specific sounds produced during the duet is unique amongst gibbons, the implications of which are discussed.

INTRODUCTION

The western hoolock gibbon (*Hylobates hoolock hoolock* Harlan, 1834) is a monogamous and territorial ape, inhabiting the tropical evergreen rain forests of Assam, Bangladesh, and Burma, from the Brahmaputra, Lohit, and Dibang rivers east to the Chindwin river (Groves 1972, Tilson 1979, Gittins 1984, Gittins and Tilson 1984). Like all other gibbon species, adult mated pairs produce loud and elaborate duets; amongst other possible functions, the duet has been proposed to serve as a means of territorial defence by advertisement of their presence in a territory, willingness to defend it, or of their relative fitness (Carpenter 1940, Chivers 1974, Marshall and Marshall 1976, Haimoff 1983, 1984).

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The frequency, pattern, and timing of the singing behaviour of wild western hoolock gibbons have been studied by Tilson (1979) and Gittins and Tilson (1984), where it was found that the adult pair sing duets only, normally in the mid-morning hours. In most other gibbon species, the adult mated males produce long and complex solo song bouts. Mated males do not sing solos in the hoolock gibbon, concolor gibbon (*H. concolor*), and siamang (*H. syndactylus*) (Haimoff 1983, 1984).

Although the duets of the hoolock gibbon were among the first to be described phonetically (see Candler 1903, McCann 1933), there have been no recent studies on the vocal repertoire of both sexes during the duet, nor have there been any studies on the structural organization of the duet. Spectrographic display of a small part of the duet (i.e. great-call sequence), have been presented by Marshall and Marshall (1976), Marler and Tenaza (1977), Gittins and Tilson (1984), and Haimoff (1984); these preliminary observations and reports indicate (at the least) that there is no apparent sexual dimorphism in their songs (i.e. no sex-specific sounds), which is unique amongst gibbon species.

An analysis of the song bouts of wild hoolock gibbons is presented here; recordings were made in Hollongapar Forest Reserve in Upper Assam by Dr. R. L. Tilson, and in West Bhanugach Forest, Sylhet, Bangladesh by Dr. S. P. Gittins, and made available for analysis. Since this species is so rare in captivity, with no adult pairs currently existing anywhere outside India, Bangladesh, and Burma (see Mootnick 1984; Schilling 1984), no direct observations or recordings of the songs of captive pairs were possible; however, some recordings were made of the singing behaviour of a lone captive female. Since no direct observations were made on adult pairs during their songs, this study is limited to presenting a catalogue of the various sounds produced by the adult pair throughout the entire song bout, in addition to presenting a preliminary analysis of the structural organization of the duet and the solo singing by the captive female.

Study Animals and Methods

Three duets (one almost complete) of the western hoolock gibbon were recorded of different groups in the Hollongapar Forest Reserve, Upper Assam, India, during a short-term behavioural ecology study of this species by Tilson (1979), which were analysed here. Also analysed were four partial duets recorded of different groups in the West Bhanugach Forest, Sylhet, Bangladesh, during the survey and preliminary observations of this hoolock gibbon subspecies by Gittins (1984) and Gittins and Tilson (1984). Since none of these groups were ever habituated, the compositions and ages of the individuals of these groups recorded, are unknown.

Direct observations and recordings of the solo singing of a lone adult female were made while she was at the San Francisco Zoo (California, USA), shortly before she was mated with a young adult male (Haimoff 1977). Unfortunately, the adult pair never duetted, and the male died of an unrelated disease shortly after the pair were brought together. This particular female has all the features of the western subspecies (see Groves 1967, 1972), as opposed to the eastern subspecies (which inhabits the tropical rain forests from the Chindwin river east to the Salween river in Burma), and is currently located at the Gibbon and Gallinaceous Bird Center (Saugus, California) (Mootnick 1984).

The songs of the lone female and the duets of the gibbons in Assam were recorded on a Uher 4400 Report Stereo IC open reel tape recorder, while the duets in Bangladesh were recorded with a Uher 4000-L Report open reel tape recorder, all of them using standard $\frac{1}{4}''$ audio tape. Audiospectrograms of all parts of these duets and solos were made, using a Kay Elemetrics 7029A sound spectrum analyser (sonagraph).

The inherent nature of the methods used by most previous analysts of gibbon songs (e.g. Marshall and Marshall 1976, Marler and Tenaza 1977), was to intuitively and possibly prematurely categorize parts of the song bout as belonging to what is known as the 'great-call sequence' (= song) and therefore worthy of note, while neglecting all other sounds produced by both sexes during the other parts of the bout. The general result is that the most elaborate and least variable parts of the song bout (the great-calls) are depicted as being produced in a vacuum.

The method used here in analysing the structural organization of the bouts has been used previously in gibbon song analysis (Haimoff 1981, 1983, 1984; Caldecott and Haimoff 1983) and human conversation analysis and behaviour (Kendon and Ferber 1973, Sacks *et al.* 1974, Schegloff *et al.* 1977). This method is essentially inductive, which avoids premature construction of categories; it involved the search for recurrent patterns throughout the entire bouts, in contrast to the immediate categorization of restricted data which has been the typical first step in the work of most previous investigators.

The problems of analysis arose when it was revealed that what previous investigators considered to represent the great-call sequence in the hoolock gibbon, was much more variable in both structure and male-female participation than exhibited in other gibbon species. In addition, since both sexes apparently produce the same types of sound throughout the entire song bout, final analysis of their duets must await further direct observations of the vocal behaviour of the adult pairs.

Results

Vocal Repertoire

Since no examinations of the vocal repertoire of both sexes of this species during their songs have been conducted, no systematic set of terms have been given to the various sounds made, other than the brief set of terms presented for some of the sounds made during the great-call sequence by Marshall and Marshall (1976) and at some other parts of the bout by Haimoff (1983, 1984). A set of terms is presented herein for the sounds made by both sexes, which is compatible and comparable with those sounds produced by other gibbon species (see Haimoff 1983, 1984).

Marshall and Marshall (1976), Marler and Tenaza (1977), Tilson (1979), and Gittins and Tilson (1984) all observed and noted that there was no clear sexual dimorphism in sound production between the sexes (i.e. that there were no overt sex-specific sounds produced by either sex) during their duet. Tilson (1979) and Gittins and Tilson (1984) did, however, observe that some sounds (described below) tended to be produced more often by the adult male, and that there were some recurrent parts of the bout which were produced by one sex or the other.

Based on the findings of this study, the beginning of the bouts were marked by the production of short *oo* and *wa-oo* notes by both sexes (fig. 1). Observations of the captive female indicate that the *oo* notes are

produced by an expiration while the lips are pursed; the *wa-oo* notes are also produced by an expiration, with the mouth and lips opening wide (the *wa* sound) and closing (the *oo* sound) during the note's production.

In addition to these notes which are also produced throughout the bout, a variety of other notes are produced, the most prominent

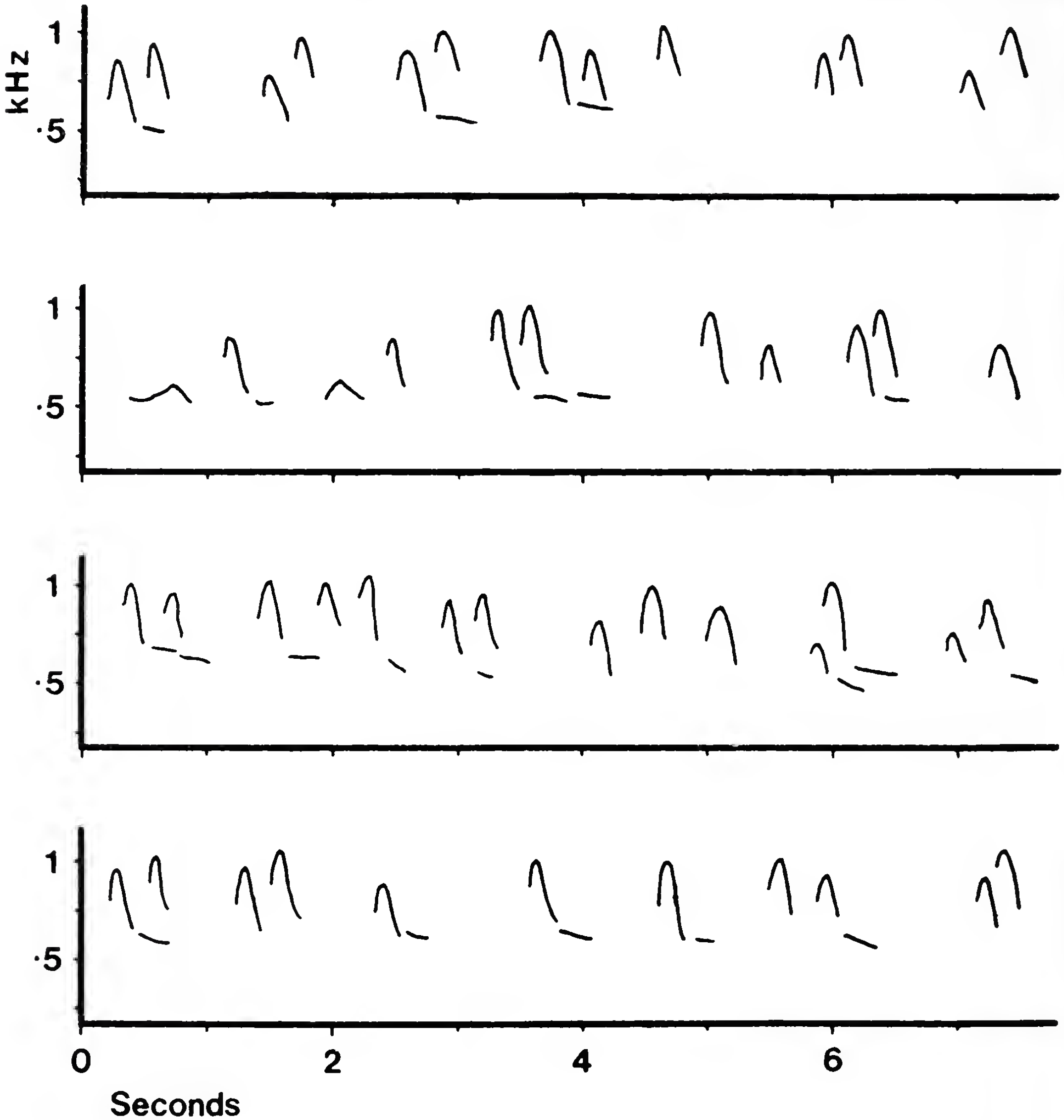

Fig. 1. Tracings of sonagrams illustrating samples of notes produced at the beginning of the duets recorded here. Since it was impossible to determine the sexes apart, these note were not distinguished by which sex produced them.

are *eek, ow,* and *wa* notes (fig. 2); all of these notes have also been observed to be produced by an expiration. The *ow* and *wa* notes are often produced as a characteristic figure (i.e. sounds almost always produced together), with the most prominent phrase produced by both sexes being the *eek* note followed by the *ow-wa* figure (fig. 2). These terms *wa, ow,*

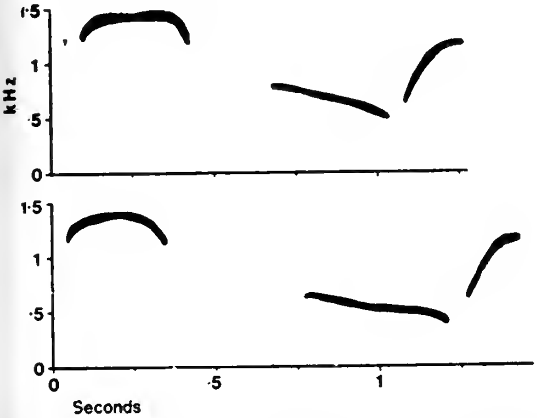

Fig. 2. Tracings of sonagrams showing the most prominent phrase produced during the organizing sequence, comprising an *eek* note followed by *ow* and *wa* notes.
(Top) a male from Hollongapar, Assam;
(Bottom) a male from West Bhanugach, Bangladesh.

and *eek,* are the same sounds as those termed *hah, who,* and *hah e*[3], respectively, which has been presented by Marshall and Marshall (1976). Another type of sound produced by both sexes is an unusual growling sound (fig. 3.) This sound is not regularly produced and its significance is not known, since it is audible for only about 50 metres (if that), indicating that it may not be for intergroup communicative value; in contrast, the other sounds described above are audible for at least 1-2 kilometres (Gittins, *pers. comm.*).

The adult females in all gibbon species produce long, standardized, and recurrent sounds during the duet, termed the 'great-call' (Marshall and Marshall 1976, Haimoff 1983, 1984). The great-call in the hoolock gibbon has been described previously as including an accelerated passage of alternating high and low notes (Marshall and Marshall 1976, Tilson 1979, Gittins and Tilson 1984). Upon closer investigation of these notes near the beginning of the great-call (figs. 4 & 5), it is clear that these notes are similar to the *wa-oo* notes which are produced at a more rapid rate as the great-call progresses, with the notes themselves becoming shorter then longer towards the end of the *wa-oo* note production.

Organization of Duet

From the recorded duets currently available for analysis which have either the beginning of the bout or just after (one Tilson's, one Gittins'), it appears as though both animals produce only *wa-oo* and *oo* notes (fig. 1), and do not produce any other notes of their communication. Both sexes produce these notes in the form of several vocal exchanges for the first several seconds (or even minutes); there was no overt progression, direction, or trend in the way the adult pair produced these sounds. Since this particular vocal behaviour is produced only once and at the beginning of the bout, it has been tentatively termed the introductory sequence, behaviour which is also exhibited during the duets of most other gibbon species (all but the concolor gibbon, *H. concolor*) (Haimoff 1983, 1984).

The transition from the production of these *wa-oo* and *oo* notes (comprising the introductory sequence) to the remainder of the bout, was much less marked than other gibbon species that produce an introductory sequence. However, the boundary marking the end of the introductory sequence may be defined as when the animals began to produce

other notes of their vocal repertoire which were not produced previously.

Although the periods after the introductory sequence (and between great-call sequences) were too variable and the sample size too small to find any overt and consistent set of vocal features throughout, by far the most prominent feature of these periods were the production of *ow-wa* figures and phrases shown in fig. 2. All adult individuals observed in the wild produced this phrase extensively (Tilson, *pers. comm.*; Gittins, *pers. comm.*), as well as the captive female. The growls were also produced during these periods (fig. 3), but less frequently. Both sexes of all wild groups also produced the *eek* note singularly or in a short succession of notes during this period (Tilson, *pers. comm.*).

also noted here, that some of the males produced one or more *ow-wa* figures after the (last) *eek* note, often in overlap with the beginning of their mate's great-call.

This vocal behaviour is indicative of some form of 'negotiation' between the adult pair prior to the production of the standardized great-call sequences, or at the very least it represents a possible coordinating cue by the male for his mate to produce her great-call. Since the periods after the introductory sequence and between great-call sequences appear to be a time by which the adult pair organize and coordinate their behaviour just prior to the production of the standardized great-call sequences, they are therefore tentatively termed the interlude sequences.

Marler and Tenaza (1977) noted that the great-calls and great-call sequences produced by adult hoolock gibbon pairs were more variable than any other gibbon species in duration, relative contribution of both sexes, and in the types of sound produced. In addition, Marshall and Marshall (1976) could not even determine the role of the sexes during this sequence, because it sounded like the cacophony of several different individuals.

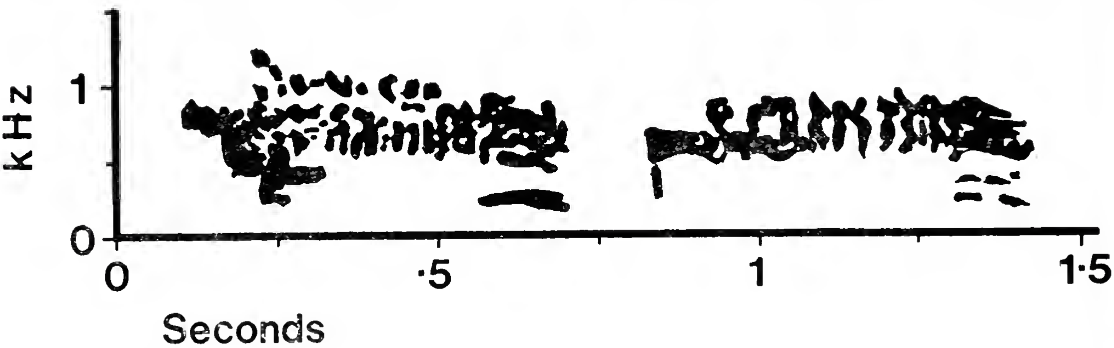

Fig. 3. Tracings of a sonagram of two 'growls' produced in succession by the captive female studied here. Note the wide frequency bandwidth of the sounds.

Tilson (1979) believed that when the adult male produced the *eek* notes in short succession, he was eliciting a response from the female in the form of her great-call; if she did not respond, he repeated the series until she began her great-call (see fig. 4). All of the 37 great-calls recorded of the wild groups studied here were preceded by *eek* notes, presumed by Tilson (1979) and Gittins and Tilson (1984) to be produced by the adult males. It was

From the brief analysis possible here, once the

male initiated the sequence by his production of *eek* notes, the female began her great-call proper which initially comprised of relatively long and separate *wa* and *oo* notes (fig. 4). Shortly after these first few notes were produced, she gave much shorter *wa-oo* notes, which were given at a more rapid pace than just before. Once she gave several notes of this type, the pace slackened where she then gave longer *wa* and *oo* notes for several seconds more. The males of the different wild groups often produced a variety of notes during this part of the great-call sequence, but became more vocal at the middle and later stages of the sequence, which varied the most.

At this particular point of the great-call sequence, the male (presumably) produced a number of *eek* notes, followed by *ow-wa* figures. The female likewise produced a number of *ow-wa* figures, and both sexes usually ended the sequence with an exchange of *wa-oo* notes. A period of silence usually ensued, with the last note prior to the period of silence representing the best definition for the boundary of the end of the great-call sequence.

Upon completion of the great-call sequences, the vocal features were characteristic of the features described above for the interlude sequences. On 11 of the 37 recorded great-call sequences analysed here, however, both sexes continued on with the rapid production of vocal exchanges of all the different notes of their vocal repertoire for up to two minutes without the slightest pause. In addition, 4 of the remaining 26 sequences seemed to end with the immediate beginning of another great-call sequence, giving the impression of two great-call sequences connected together. Therefore, no accurate measurements of their great-call sequences could be made until further observations and several recordings are made on specific groups, so as to account for both the individual variation within groups and the range of variability in the structural organization of the great-call sequences.

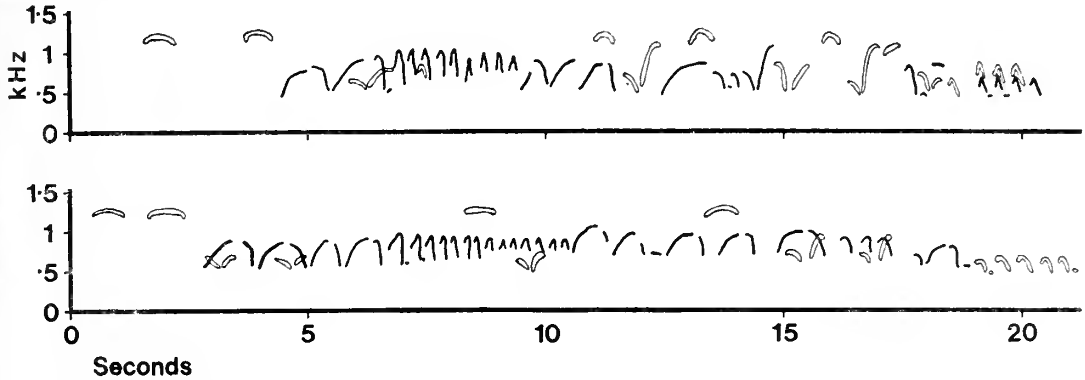

Fig. 4. Tracings of sonagrams illustrating the structural organization of the great-call sequences in two groups (the females' sounds are in closed shapes, the males' are in open shapes). Note initial high pitched *eek* notes at far left of both tracings, and the females' great-calls which includes an accelerated passage of *wa-oo* notes. (top) a pair from West Bhanugach, Bangladesh; (bottom) a pair from Hollongapar, Assam.

Solo Singing of a Lone Female

Female solo singing is believed to be a very

rare phenomenon, presumed to occur only in females who have either lost or have been separated from their mates; their solo singing has therefore been proposed to serve as a means of either attracting their mate or a new one, and has been reported in four of the nine gibbon species (*H. hoolock*: Marshall and Marshall 1976, Haimoff 1983; *H. lar*: Marler and Tenaza 1977; *H. klosii*: Tilson 1981; *H. pileatus*: Srikosamatara 1982). Observing a lone female hoolock gibbon at the Calcutta zoo, Marshall and Marshall (1976) reported that not only did she sing alone; but that she sang the male's apparent contribution to the great-call sequences as well. Although it is still not clear as to the precise extent of the male's vocal (and non-vocal) contribution to the sequences of the duet, similar behaviour has also been observed of lone female hoolock gibbons at the Bombay zoo (Dr K. K. Tiwari, *pers. comm.*) and San Francisco Zoo (*pers. obs.*) (this female currently located at the Gibbon and Gallinaceous Bird Breeding Center).

When the lone female was located at the San Francisco Zoo, she never sang for any sustained duration (more than about five minutes), but did tend to sing at various times throughout the day. She would most often produce the notes characteristic of the interlude and great-call sequences, usually as a result of either being teased by spectators or from the singing of other gibbon groups (*H. syndactylus* and *H. concolor*), which were close by and within visual contact with each other. On rare occasions, however, she initiated the singing and stimulated the other groups into duetting, then sang intermittently throughout the duets of the other gibbon groups at the zoo.

It is noteworthy here to point out that she never began singing by producing the notes described for the initiation of the duets in wild groups (the introductory sequence), instead bursting out with several phrases like those shown in fig. 2, with growling sounds intermingled between, and followed by what is interpreted here to represent her great-call (fig. 5). Although the structure of her great-call was variable (much more so towards the end) and not well defined, she did produce the entire range of sounds documented for this species during the great-call sequence, and did produce the characteristic acceleration of *wa-oo* notes.

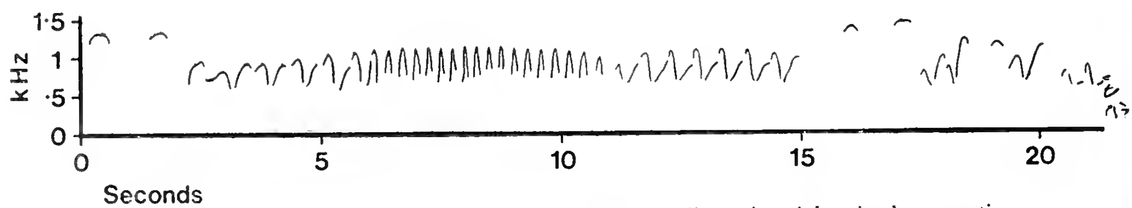

Fig. 5. Tracings of sonagrams illustrating the great-call produced by the lone captive female. Note the *eck* notes at the start, which has previously been presumed to be produced by the male just before her great-call. Since the extent of the male's vocal contribution to the great-call sequence is not yet clearly defined, the extent of the vocal imitation of the male's contribution by the female cannot yet be determined.

What is interpreted here to be the lone female's great-call (fig. 5), is strikingly similar to those of normally organized great-calls (and sequences) (fig. 4); although from fig. 5, one could not yet conclude conclusively that the

female attempted to produce the male's contribution to the great-call sequence. This female did however, produce the *eek* notes just prior to her great-calls, which have previously been observed in wild groups to be produced by the male only (Tilson 1979, Gittins and Tilson 1984). If further analyses of the solo singing of this female (and others already observed) do conclude that they were producing the male's contribution to the great-call sequences, then the functional significance proposed previously for the solo singing of females, must be reassessed.

Discussion

Based on the findings presented here, the overall acoustical features of most sounds produced by the hoolock gibbon are virtually identical to those of other gibbon species (Marshall and Marshall 1976, Marler and Tenaza 1977, Haimoff 1983); however, the growling sounds analysed here are a unique feature, in that they are the only sounds produced during the duet which are not pure toned. There also appears to be a complete lack of sexual dimorphism in the vocal repertoire of both sexes (i.e. no sex-specific sounds) of this species during the duet, which is also a unique feature amongst gibbon species; the accelerated passage of notes at the start of the great-call sequence seems to be characteristic of the female only. Although the structural organization of the duet has been found to be generally similar to other gibbon species in the way three sequences have been tentatively identified (introductory, interlude, and great-call) (see Haimoff 1983, 1984), both sexes contribute vocally during all three, a feature shared only with the siamang (*H. syndactylus*) (Haimoff 1981).

Intergroup communication in the form of territorial defence and mate defence by advertisement have been the main functions proposed for gibbon duets (Carpenter 1940, Chivers 1974, Tenaza 1976, Gittins 1979, Haimoff 1983, 1984). Since hoolock gibbon family groups live in defended territories of about 20-25 hectares (50-62 acres) (Gittins and Tilson 1984), the selective pressures on the acoustical features of their duets should be (if the proposed functions were accurate) for the long-range propagation of sound and penetration through the forest of the songs.

With regards to the environment in which the hoolock gibbon lives, there are three (at the least) ecological factors and constraints directly affecting the evolution of the acoustical properties of their songs: 1) the complex structural properties of the dense tropical forest canopy produce 'sound windows', the attenuation of sounds produced at these frequencies is less than for sounds made at higher or lower frequencies (Morton 1975), while the foliage acts as an amplifier of the sounds made in the midfrequencies (Martens 1980); 2) sounds with wavelengths shorter than objects in the sound path will be reflected and partly absorbed, whereas sounds with longer wavelengths will not (Stephens and Bate 1966); and 3) lower frequency sounds are absorbed less rapidly by humid air (a constant feature in the rain forest) than high frequency sounds (Evans and Bass 1972 *in* Waser and Waser 1977).

If the selection for long-distance propagation of sound through the forest was a major factor in the evolution of the songs of the hoolock gibbon (and other gibbon species), then the acoustical features of their songs indicating that this process had taken place, are as follows: 1) compressing all of the sound energy into a narrow frequency bandwidth, so as to minimize energy loss and attenuation; 2)

producing sounds within the low- to mid-frequencies (within the sound window); and 3) evolving the vocal tract and apparatus to reinforce the sounds made at these frequencies at the expense of harmonics, which would be filtered out by the forest canopy. All of these features are exhibited in all sounds made (except the growl) during the song of the hoolock gibbon, indicating that the sounds evolved for the long-range propagation through the forest, possibly for inter-group communicative purposes. The growling sounds may therefore not be considered as having any inter-group communicative value, but may be used by the adult pair as a possible coordinating cue in the organization of the duet or perhaps as an agonistic sound (Gittins, *pers. comm.*).

The unusual lack of any sexual dimorphism in the singing behaviour of this species is difficult to account for, since all of the previous studies proposing a function of territorial advertisement for the duets (cited above), suggested that the clearly dimorphic sounds made by both sexes transmitted a message of relative fitness to non-mate conspecifics of the same sex; a proposal which is clearly not applicable to the vocal behaviour of the hoolock gibbon. It is possible, however, that the message transmitted by a hoolock gibbon pair may be of the relative fitness or strength of the pair as a whole in a given territory, not as individuals as may be the case in other gibbon species. Further detailed analyses of their songs would be necessary to account for this feature more adequately.

The organization of the duet bout by the hoolock gibbon has been found here to be generally similar to those of other gibbon species in the way the adult pair produce sounds characteristic of the beginning of the bout (the introductory sequence), followed by relatively distinct sequences which are then produced in alternating succession (the interlude and great-call sequences). Preliminary analysis of these duets indicate that they are a complex and interactively organized phenomena; the complex duetting behaviour of the siamang has been proposed by Chivers (1974, 1976) and Haimoff (1981, 1983) to serve as the basis for the maintenance, cohesion, and reinforcement of the pairbond. Although Serpell (1981) has disputed this, it would appear that since duetting is virtually the only social behaviour in which the adult pair may react to the same stimulus and engage in an interactive manner to produce the mutually coordinated display, the mere presence of such behaviour would necessarily have some effect on the cohesiveness of the pairbond.

From the context in which the introductory sequence is produced, it seems likely that this sequence initiates the duet as a possible form of warming up, prior to the production of more 'difficult' sounds and its associated vigorous activity. The great-call sequences are apparently analogous to the features which characterize the 'song' of a bird species (see Thorpe 1961), being the most conspicuous and elaborate sequence, representing the least variable of sequences and possibly the part of the bout transmitting the information of the singer's fitness. As argued by Haimoff (1981, 1983, 1984), since these great-call sequences are a highly organized and complex activity from the beginning, it would not be surprising to observe that the adult pair may need a period prior to the start of the great-call sequences in order so that they may prepare, organize, and coordinate their behaviour for such a complex, sequence. The interlude sequences were termed as such, because they were always quite variable in vocal terms and thus the actual sounds made were probably of little communicative value between groups.

but it did appear to be a time when the adult oriented themselves to produce the great-call sequences (as indicated by the male's production of the *eek* notes). The unusual nature of the variability of all three sequences in the hoolock gibbon's duet, and less marked boundaries between sequences in comparison with other gibbon species, must await further analysis.

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ENVIRONMENTAL FACTORS AND PLANKTONIC COMMUNITIES OF BAIGUL AND NANAKSAGAR RESERVOIRS, NAINITAL[1]

SALEEM MUSTAFA AND ZUBAIR AHMAD[2]

Studies were carried out on physico-chemical conditions and the plankton in two reservoirs, Baigul and Nanaksagar. The duration of investigations extended from April to September. Monthly fluctuation in the various environmental factors have been discussed and their influence on planktonic organisms highlighted.

INTRODUCTION

Rational management of fisheries in large impoundments requires a thorough knowledge of the environmental conditions. Increased attention must, therefore, be given to the limnological characteristics such as physico-chemical and biological conditions prevailing in the water bodies since these directly or indirectly affect the lives of fishes and other aquatic inhabitants. Although considerable literature exists on the limnology of several Indian reservoirs (Ganpati 1940, 1960, Rao and Govind 1964, Sreenivasan 1964, Upadhayaya 1964, Sreenivasan 1965, 66, Armitage and Simmon 1975, Planas 1975, Jayangoudar, 1980, Kannan and Job 1980), the authors are not aware of any satisfactory published report on the Baigul and Nanaksagar reservoirs. These reservoirs are located in district Nainital, Western Uttar Pradesh. The area covered by the basin of the Baigul is estimated to be 118 square miles while that of Nanaksagar is as large as 220.6 square miles. An attempt was, therefore, made to present information on the physico-chemical conditions and plankton populations of the two reservoirs.

MATERIALS AND METHODS

Water samples were collected monthly from the Baigul and Nanaksagar reservoirs at a fixed time to avoid the influence of diel fluctuations. Three sampling sites were selected in each reservoir and from each site 100 ml water sample was collected from the surface, transferred to the bottles and fixed by addition of Lugol's solution for subsequent analysis of phytoplankton. Incubation of the samples for 24 hours at room temperature, resulted in sedimentation of plankton. By siphoning out the supernatant liquid, leaving only 10 ml of the basal content, plankton were concentrated. Known volumes of this plankton concentrate were examined under the microscope. Plankton were identified up to generic level with the help of keys given by Ward and Whipple (1963) and Needham and Needham (1964). The number of phytoplankton were expressed per milli-litre of the environmental sample.

For studies on zooplankton, 100 litres of water was filtered through a plankton net made up of organdi cloth and sample was collected in a specimen tube of known volume tied at the rear end of the conical net. 10%

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TABLE 1

PHYSICO-CHEMICAL CONDITIONS OF RESERVOIRS

Conditions	Baigul					Nanaksagar				
	April	June	July	August	September	April	June	July	August	Sept-ember
Air temperature (°C)	36.2	34.9	30.0	32.4	33.5	35.8	34.2	30.0	33.4	33.7
Water temperature (°C)	34.2	33.9	28.9	31.9	33.0	33.6	33.4	29.5	32.9	33.0
Transparency (cm)	140	120	80	84	88	160	150	100	105	109
pH	7.8	7.2	7.2	7.6	7.7	7.8	7.1	7.2	7.5	7.6
Dissolved oxygen (ppm)	8.0	7.8	6.5	7.2	7.8	7.8	7.6	6.6	7.2	7.6
Carbonate (ppm)	25	19	9	12	17	24	19	8	11	18
Bicarbonate (ppm)	80	78	76	77	77.5	80	78	75	76	76
Carbondioxide (ppm)	—	—	—	—	—	—	—	—	—	—
Chloride (ppm)	15.0	13.0	8.3	8.3	8.6	15.0	12.0	8.6	8.8	9.2

formalin was added as a preservative. Measured sub-samples were examined under microscope. The number of organisms per litre was computed.

Atmospheric and surface water temperatures were recorded by mercury thermometer graduated up to 100°C. Transparency of water was measured by standard secchi disc.

Water samples for chemical analysis were collected in the morning from the surface. Oxygen concentration was determined by the standard Wrinkler's method. Carbonate and bicarbonate were estimated by titrating 100 ml samples of water with N/50 sulfuric acid using phenolphthalein and methyl orange as indicators. Presence of carbondioxide was tested by phenolphthalein. Chloride was estimated by titrating 50 ml of sample with standard silver nitrate solution using potassium chromate as indicator (Barnes 1959). Hydrogen ion concentration was indicated by pH paper readings.

For comparison of plankton composition in Baigul and Nanaksagar reservoirs, a 'similarity co-efficient' was calculated using the formula as adopted by Beattie *et al.* (1978):

$$S = \frac{2c}{a+b}$$

where S = Similarity co-efficient; c = number of the types of organisms common in the two reservoirs; a = number of the types of organisms in one reservoir (Baigul); b= number of the types of organisms in other reservoir (Nanaksagar).

The value of this co-efficient varies from 0 to 1 depending upon the amount of similarity or difference.

RESULTS

(A) *PHYSICO-CHEMICAL CONDITIONS*

The physico-chemical conditions of the

Baigul and Nanaksagar reservoirs have been tabulated (Table1).

1. Temperature. Air temperature ranged from 30°C in July to 36.2°C in April at Baigul. At Nanaksagar also the minimum temperature was recorded in July (32.2°C) and maximum in April (35.8°C). Trend of monthly fluctuation in the surface water temperature was exactly identical to that of atmospheric temperature, the maximum value in the month of April was 34.2°C in Baigul and 33.6°C in Nanaksagar. While the minimum obtained in July was found to be 28.9°C in Baigul and 29.5°C in Nanaksagar. Air and water temperatures increased gradually from July to September.

2. Transparency. Secchi disc reading varied from 80 cm to 140 cm in Baigul and 100 cm to 160 cm in Nanaksagar. During the period of investigation, water transparency was observed highest in April, poorest in July and medium in September.

3. pH. Maximum pH value (7.8) was recorded in the month of April in both the reservoirs and minimum (7.2) in Baigul and 7.1 in Nanaksagar in June. pH seemed to increase from July to September.

4. Dissolved Oxygen. Highest concentration of dissolved oxygen was noted in the month of April (8 ppm in Baigul and 7.8 ppm in Nanaksagar) and lowest in the month of July (6.8 ppm in Baigul and 6.6 ppm in Nanaksagar). The values were higher in the month of September compared to that of June.

5. Carbondioxide. Carbondioxide was absent in all the reservoir water samples during the period of investigation.

6. Carbonate. Carbonate content of water varied from 9 ppm to 25 ppm in Baigul and 8 ppm to 24 ppm in Nanaksagar. Peaks were recorded in the month of April and trough in July in both the reservoirs.

7. Bicarbonate. Bicarbonate ranged from 76 ppm in July to 82 ppm in April (Baigul) and 73 ppm in July to 80 ppm in April (Nanaksagar).

8. Chloride. Chloride concentration in both the reservoirs was low and pattern of variation was similar to carbonate. The maximum concentration (15 ppm in both the reservoirs) and minimum (8.3 ppm in Baigul and 8.6 ppm in Nanaksagar) were observed in the month of April and July, respectively.

(B) *PLANKTON*

Little generic difference in the phyto- and zooplankton existed in the Baigul and Nanaksagar. This was revealed from the value of similarity co-efficients (0.90 for phytoplankton and 0.83 for zooplankton).

1. Phytoplankton. Population estimates of the various genera of the phytoplankton have been indicated in Table 2. The phytoplankton in Baigul and Nanaksagar reservoirs mainly consisted of chlorophyceae, myxophyceae, desmidiaceae and bacillariophyceae. Their mean percentages were 34.4 13.3, 17.4, 35.7 in Baigul and 32.2, 14.7, 20.8, 32.0 in Nanaksagar, respectively.

Chlorophyceae. This group was encountered in large numbers throughout the study period. *Protococcus* was numerically the most superior. This was followed by *Ankistrodesmus.* April was the period of dominance. The number dwindled in September. Other genera *Tetraedron, Botryococcus, Pediastrum, Coelastrum, Scenedesmus, Oocystis, Oedogonum, Crucigenia, Phaeus, Tetraedriella, Arthrodesmus* and *Zygnena* occurred in moderate numbers, being high in summer months and low in the monsoon. *Kirchneriella* and *Gunodium* were present in Baigul and absent from Nanaksagar.

Myxophyceae was represented by only four genera in each reservoir, the dominating

TABLE 2

PHYTOPLANKTON ABUNDANCE IN THE RESERVOIRS (NUMBER/MILLILITRE)

GENERA	Baigal							Nanaksagar						
	April	June	July	August	September	Mean	S.E.	April	June	July	August	September	Mean	S.E.
Tetraedron	52	43	35	43	35	41.6	± 3.16	52	52	43	26	26	39.8	± 5.87
Selenastrum	70	52	35	35	35	45.4	± 6.98	70	61	61	70	61	64.6	± 2.2
Botryococcus	79	70	43	43	43	55.6	± 7.85	70	61	43	35	26	47.0	± 8.14
Pediastrum	79	70	61	43	52	61.0	± 6.36	70	52	35	43	43	48.6	± 5.99
Coelastrum	61	61	—	43	43	41.6	±11.15	52	52	43	52	—	38.8	±10.1
Ankistrodesmus	70	61	148	43	79	80.2	±17.96	52	43	35	52	43	45.0	± 3.21
Scenedesmus	70	70	61	52	52	61.0	± 4.02	52	26	26	43	35	36.4	± 5.03
Kirchneriella	26	26	35	17	26	26.0	± 2.85	—	—	—	—	—	—	—
Oocystis	35	26	—	17	26	20.8	± 5.93	43	35	26	43	17	32.8	± 5.04
Oedogonium	43	26	35	17	26	29.4	± 4.43	26	26	26	35	26	27.8	± 1.8
Crucigenia	70	52	52	43	52	53.8	± 4.41	61	61	52	35	35	48.8	± 5.89
Phacus	26	17	43	17	26	25.8	± 4.75	43	35	26	26	35	33.0	± 3.21
Protococcus	123	96	96	96	96	101.4	± 5.40	114	88	70	70	61	80.6	± 9.43
Tetraedriella	79	61	17	43	43	48.6	±10.35	52	43	35	35	35	40.0	± 3.38
Gunodium	70	52	35	52	52	52.2	± 5.45	—	—	—	—	—	—	—
Arthrodesmus	35	17	35	26	35	29.6	± 3.6	35	26	17	26	35	27.8	± 3.37
Zygnema	96	79	79	61	70	77.0	± 5.81	61	35	35	79	61	54.2	± 8.5
GREEN Total	1084	879	810	691	791	851.0	±65.56	853	696	573	670	539	666.2	±55.07
ALGAE Percentage	33.83	31.50	37.02	31.07	33.76	33.44	± 1.06	32.42	33.9	30.79	35.45	28.76	32.26	± 1.17
Oscillatoria	52	43	43	43	43	44.8	± 1.8	43	43	43	35	35	39.8	± 1.96
Clastidium	123	149	167	122	96	131.4	±12.23	149	131	114	88	79	112.2	±13.04
Phormidium	35	35	52	17	26	33.0	± 5.81	26	9	26	35	35	26.2	± 4.75
Anabaena	236	201	43	79	114	134.6	±36.47	166	126	123	114	105	126.2	±10.49
BLUE GREEN Total	446	428	305	261	279	343.8	±38.79	384	306	306	273	254	304.0	±22.28
ALGAE Percentage	13.92	15.34	13.94	11.73	11.90	13.37	± 0.68	14.59	14.9	16.44	14.39	13.55	14.77	± 0.47
Closterium	271	245	449	201	158	204.8	±23.79	166	149	131	114	114	134.8	±10.14
Mesotaenium	43	35	52	17	35	36.4	± 5.78	43	26	26	26	52	34.6	± 5.46
Cosmarium	52	44	43	43	43	45.2	± 1.71	52	35	43	52	61	48.6	± 4.43
Staurastrum	131	96	61	61	70	83.8	±13.43	96	96	61	26	52	66.2	±13.46
Gonatozygon	61	43	—	26	35	33.0	±10.20	52	43	43	26	—	32.8	± 9.22

TABLE 2 (contd.)

Penium	—	—	35	—	43	15.6	± 9.64	—	—	—	—	35	7.0	± 7.0
Euastrum	35	26	26	17	35	27.8	± 3.37	35	26	35	17	26	27.8	± 3.37
Actinastrum	—	—	—	—	—	—	—	52	26	26	35	35	34.8	± 4.75
Drapanaldia	—	—	—	—	—	—	—	—	17	17	26	26	17.2	± 4.75
Micrastarias	—	—	—	—	—	—	—	26	26	17	26	26	24.2	± 1.8
DESMIDS Total	593	489	367	365	419	446.6	±43.0	522	444	399	348	427	428.0	±28.58
Percentage	18.51	17.53	16.77	16.41	17.88	17.42	± 0.38	19.84	21.62	21.44	18.41	22.78	20.82	± 0.76
Cocconies	52	43	52	52	62	52.0	± 2.85	43	35	35	26	35	34.8	± 2.69
Rhopalodia	52	35	61	17	26	38.2	± 8.12	—	—	—	—	—	—	—
Cyclotella	43	35	26	17	35	31.2	± 4.45	43	17	17	35	35	29.4	± 5.27
Melosira	96	70	52	70	61	69.8	± 7.35	70	43	43	43	43	48.4	± 5.04
Diatoma	131	131	143	87	96	97.6	±16.32	17	61	61	96	105	78.6	± 9.20
Tabellaria	52	43	—	35	43	34.6	± 9.06	79	43	35	26	—	36.6	± 2.83
Gyrosigma	61	61	52	61	35	54.0	± 5.06	—	—	—	—	—	—	—
Nitzschia	149	158	96	167	114	136.8	±13.59	184	122	114	105	114	127.8	±14.31
Synedra	140	149	79	131	96	119.0	±13.44	184	122	131	122	140	139.8	±11.54
Navicula	114	131	105	140	122	122.4	± 6.15	52	43	35	26	43	34.8	± 4.37
Epithemia	52	43	35	43	52	45.0	± 3.21	43	43	52	43	52	46.6	± 2.20
Amphora	61	43	35	52	61	50.4	± 5.1	52	43	43	52	52	48.4	± 2.2
Surirella	43	26	35	26	26	31.2	± 3.43	43	35	17	26	35	31.2	± 4.45
Fragillaria	35	26	35	9	26	26.2	± 4.75	—	—	—	—	—	—	—
DIATOMS Total	1081	994	706	907	854	908.4	±63.66	865	607	583	600	654	661.2	±51.56
Percentage	33.74	35.63	32.26	40.78	36.45	35.77	± 1.45	32.76	29.57	31.33	31.75	34.90	32.06	± 0.88
TOTAL PHYTOPLANKTON	3204	2790	2188	2224	2345	2549.8	±195.64	2631	2053	1861	1890	1874	2061.8	±146.49

genus being *Anabaena*. Next to it in order of abundance were *Clastidium, Oscillatoria* and *Phormidium*. Their population densities were high in summer and low in monsoon.

Desmidiaceae. This group was represented by 10 genera in Nanaksagar and 7 in Baigul reservoir. *Drapanaldia, Micrastarias* and *Actinastrum* did not occur in Baigul. *Clasterium* was noted for its dominance in both the reservoirs, followed by *Staurastrum, Cosmarium, Gonatozygon, Euastrum* and *Mesotaenium*. Their numbers were high in April and low in monsoon. *Penium* was found only in the last sampling month in the reservoirs.

Bacillariophyceae. *Synedra* and *Nitzschia* were the most preponderant in Baigul as well as Nanaksagar. Others including *Diatoma, Navicula, Melosira* and *Amphora* were recorded in moderate numbers. The population densities of *Cocconies, Cyclotella, Tabellaria, Epithemia* and *Surirella* were low in the two reservoirs. Most of the genera showed their peak in summer months and trough in the monsoon season. Three more genera, viz. *Rhopalodia, Gyrosigma* and *Fragillaria* were found only in the Baigul.

2. *Zooplankton*. The genera recorded from the Baigul and Nanaksagar reservoirs belonged to four groups : Cladocerans, Copepods, Rotifers and Ostracods. Data for this have been given in Table 3.

Cladocerans. Occurrence of this group was high in Baigul compared to Nanaksagar. A total of five genera: *Scaphopoda, Bosmina, Diaphanosoma, Scapholebris* and *Simocephalus* were recorded in Baigul reservoir, but out of these, *Scapholebris* and *Simocephalus* were not found to occur in Nanaksagar. Cladocerans showed a direct relationship with phytoplankton as their numbers were high in summer months and low in monsoon.

Copepods. This group consisted of *Cyclops, Diaptomus* and their nauplii larvae. Their maximum numbers were recorded in the month of September, moderate numbers in April and low in July. Nauplii were found from July onward.

Rotifers. *Brahionus* and *Keretella* were the two genera common to both the reservoirs. These were most abundant in April and their population seemed to decline in monsoon. *Fillinia* and *Colurella* were observed in Nanaksagar only in the last two months.

Ostracods. *Entocythere, Cypticercus* and *Cyprinotus* were the only representative genera in Baigul and Nanaksagar. Their population densities were high in April and June and lower in the month of July. *Cyprinotus* were obtained in summer.

Discussion

Thermal conditions in the superficial layers of reservoir water are chiefly influenced by atmospheric temperature. Hence the identity in the pattern of variation in the temperature of air and water. The premonsoon period is generally characterised by intense solar radiations and high temperature of air and water. With the onset of monsoon rains in July cloudy weather and weak radiations, the temperature of air and water is markedly lowered.

High transparency of water in April seemed to be related to greater amount of sunshine, better penetration of light, moderate velocity of wind and hence stillness of water and lesser proportion of dissolved and suspended matters. Some of the causative factors have been identified earlier (Welch 1952, McCombine 1953, Ruttner 1953, Hutchinson 1957, Bamforth 1958). Decline in transparency in the monsoon could be attributed to cloudy condition, poor sunshine and inrush of surface run off

TABLE 3

ZOOPLANKTON ABUNDANCE IN BAIGUL AND NANAKSAGAR RESERVOIRS (NUMBER/LITRE)

GENERA	Baigul April	June	July	August	September	Mean	S.E.	Nanaksagar April	June	July	August	September	Mean	S.E.
Cyclops	75	53	21	43	80	54.4	±10.79	75	53	48	37	53	53.2	± 6.18
Diaptomus	16	27	21	27	59	30.0	± 7.54	37	59	48	43	176	72.6	±26.10
Nauplii Larvae	—	—	11	43	21	15.0	± 8.01	—	—	37	32	16	17.0	± 7.76
COPEPODS Total	91	80	53	113	160	99.4	±17.97	112	112	133	112	245	142.8	±25.87
Percentage	11.27	17.66	19.85	27.43	32.99	25.43	± 3.57	19.79	23.04	34.10	27.65	49.29	30.77	± 5.21
Scapholebris	149	43	11	21	21	49.0	±25.54	—	—	—	—	—	—	—
Scaphopoda	64	43	—	32	37	35.2	±10.35	85	43	43	27	27	45.0	±10.62
Bosmina	59	37	21	21	27	33.0	± 7.13	43	37	37	21	11	29.8	± 5.95
Diaphanosoma	59	32	27	32	59	41.8	± 7.08	75	43	11	21	21	34.2	±11.46
Simocephalus	11	16	21	27	21	19.2	± 2.69	—	—	—	—	—	—	—
CLADO- Total	342	171	80	133	165	178.2	±44.01	203	123	91	69	59	109.0	±25.94
CERANS Percentage	42.38	37.75	29.96	32.28	30.02	33.02	± 3.91	35.86	25.31	23.33	17.04	11.87	29.58	± 4.43
Keretella	43	43	21	5	27	27.8	± 7.17	43	37	32	27	27	33.2	± 3.01
Brachionus	27	21	27	16	21	22.4	± 2.09	32	43	21	11	21	25.6	± 5.47
Fillinia	—	—	—	—	—	—	—	—	—	—	27	11	7.6	± 5.30
Colurella	—	—	—	—	—	—	—	—	—	27	21	21	13.8	± 5.70
ROTIERS Total	70	64	48	21	48	50.2	± 8.71	75	80	80	86	80	80.2	± 1.74
Percentage	8.67	14.13	17.97	5.09	9.89	11.1	± 2.23	13.25	16.46	20.51	21.23	16.09	17.51	± 1.48
Cyprinotus	—	—	48	43	—	18.2	±11.17	—	—	—	37	43	16.0	± 9.84
Entocythere	304	69	27	43	59	100.4	±51.4	59	80	27	48	27	48.2	±10.07
Cypricercus	—	69	11	59	53	308.4	±13.78	117	91	59	53	43	72.6	±13.70
OSTRA- Total	304	138	86	145	112	157.0	±38.19	176	171	86	138	113	136.8	±17.11
CODS Percentage	37.67	30.46	32.21	35.19	23.09	31.72	± 2.47	31.09	35.18	22.08	34.07	21.74	29.02	± 2.79
TOTAL ZOO-PLANKTON	807	453	267	412	485	484.8	±88.76	566	486	390	405	497	468.8	±32.26

laden with silt and different kinds of organic material causing turbidity in water.

No appreciable difference was noted in the temperature of water of the two reservoirs. Baigul water was more turbid, with lesser transparency.

Amount of oxygen dissolved in water depends upon the partial pressure of the gas in the air, close to the water surface, rate of photosynthetic activity (which releases oxygen) in the ecosystem and the oxygen holding capacity of water. It has conclusively been proved that temperature of water and concentration of salts determine the quantity of oxygen which can be dissolved in the water. Although the oxygen holding capacity of water reduces at higher temperature. Yet high dissolve oxygen values in April (hottest of the months investigated) and low values in July, a relatively cooler month observed by the authors serve to emphasize the overriding influence exerted by factors (other than temperature) such as penetration of light to a larger depth, greater abundance of photosynthesizing organism on the dissolved oxygen level of the water.

Carbondioxide was not found in a free state in the two reservoirs, but occurred in combination with other substances. Immediately on being produced during metabolic activity of the reservoir's biota, it is used up in photosynthesis or gets combined with the available carbonate to form bicarbonate. Such a sequence of chemical transformation has been documented by Welch (1952). In several other Indian reservoirs investigated the free carbondioxide has also not been detected (Rao and Govind 1964, Upadhayaya 1964, Sreenivasan 1972).

Carbonate and bicarbonate contents of water showed similar trend of monthly fluctuations in both the reservoirs, related evidently to temperature and water level. Ambient temperature before monsoon leads to more evaporation and decrease in the water level. This increases the concentration of carbonate and bicarbonate. Following the rains, fall in temperature and hence evaporation coupled with the influx of a large volume of water, these substances got diluted. Rao and Govind (1964) have also correlated alkalinity fluctuations with the temperature and rainfall. Pattern of pH changes resembled that of carbonate content of the water. This is consistent with findings of Lauff (1953) and Jana and Sarkar (1971).

Chloride concentration in both the reservoirs was very low which indicated that they were well protected from pollution. That high concentration of chloride is suggestive of pollution has been emphasized by Sarkar and Rai (1964). Dynamics of change in chloride content of the reservoirs emphasizes that the two main factors, viz. temperature and rainfall, which bring about changes in carbonate and bicarbonate also lead to alterations in chloride content.

Biomass production of both the reservoirs seemed to be affected by the physico-chemical conditions of the ecosystem. Higher temperature and light penetration (April to June) appeared to cause increased production of plankton in general. Green algae flourished when the temperature was highest and the diatoms when the temperature was moderate.

Blooming of phytoplankton in the month of April has been reported by Sreenivasan *et al.* (1974), Arumugon and Furtado (1980) and Kannan and Job (1980) in some temperate and tropical reservoirs. Bhardwaja (1940) and Michael (1969) have also pointed out temperature and light as the factors responsible for the higher population of phytoplankton. According to Worrington (quoted by Round

1961) tropical waters are more productive on account of higher temperature. In temperate areas also it is known that changes in water temperature affect the seasonal cycle of phytoplankton (McCombie 1953). Contrary to these findings Talling (1957), Sreenivasan *et al.* (1974) and Andreoli and Rascio (1975) could not observe direct influence of temperature on phytoplankton.

In Baigul and Nanaksagar both, phytoplankton density reduced in monsoon months. Similar to this observation Sreenivasan (1964), Saha *et al.* (1971) and Kannan and Job (1980) encountered minimum number of phytoplankton in the monsoon months. Welch (1952) suggested that the higher turbidity values unfavourable to the growth of plankton. Roy (1955) observed that turbidity limits the growth of plankton population due to the blanketing effect of suspended materials interfering with photosynthetic activity of phytoplankton. Rainfall alters physico-chemical conditions in the water and influences the planktonic life (Berner 1951, Chandler and Weeks 1954). Kannan and Job (1980) attributed the low density of phytoplankton in rainy season to : dilution of medium. loss through outlet and silting. Sreenivasan (1964) reported excessive flooding as the causative factor of low population of phytoplankton in monsoon months.

The monthly variations in zooplankton population during the period of investigation were similar in the two reservoirs. Maximum numbers of crustaceans, rotifers and ostracods were recorded in the month of April and minimum in July. Factors like temperature, turbidity, pH, discharge of water from tributaries, breeding rate of zooplankton, selective predation of large zooplanktons on smaller ones are reported to cause fluctuations in the population of these invertebrates (Cowell 1967, Vasisht 1968). Higher temperature in the month of April might enhance the breeding rate of crustaceans. Abundance of phytoplankton in this month also seemed to favour the growth of crustaceans which generally feed on minute phytoplankton in addition to other organic matter (Vaas and Vaas-Van-Oven 1959). According to Arora (1966) high pH and temperature are responsible for the change in rotifer population. Factors like turbidity, flooding etc., which tend to curtail phytoplankton population also result in numerical decline of the zooplankton.

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OBSERVATIONS ON THE SOCIAL ORGANISATION AND SEX RATIO IN THREE SPECIES OF INDIAN BATS[1]

A. Krishna and C. J. Dominic[2]

Data on the social organisation and sex ratio in three species of bats, namely *Scotophilus heathi, Taphozous longimanus* and *Cynopterus sphinx* are presented. In *S. heathi* harem formation occurs during the breeding season. At other times the females live in small unisexual groups, while the males remain solitary. In *T. longimanus* individuals are found during the breeding season in mixed groups of 15-25 females and 5-10 males; during the non-breeding season females roost in large colonies while males are found in small groups. In *C. sphinx* the sexes remain separate, except during the mating season and during the winter months. In all the three species the sex ratio is even in the juveniles. However, in *S. heathi* and *T. longimanus* there is an uneven sex ratio among adults favouring the females, whereas in *C. sphinx* the adult sex ratio is almost even.

Introduction

Several studies suggest that in bats there is an unbalanced sex ratio in the adults with females outnumbering the males in most species (Wimsatt 1945, Gopalakrishna 1947, 1955, Ramakrishna 1951, Pearson *et al.* 1952, Abdulali 1949, Ramaswamy 1961, Brosset 1962a, b, c, 1963, Gopalakrishna and Madhavan 1970). However, the sex ratio is even during juvenile life in these species. *Taphozous melanopogon* and *Hipposideros lankadiva* are the only species in which the males exceed the females (Abdulali 1949). An unequal sex ratio is also reported in hibernating colonies of bats (cf. Bradbury 1977).

Due to the nature of the roosts and the nocturnal habits and due to the practical difficulties in tracking one population which involves trapping, marking and periodic censusing of entire groups, social organisation, especially social dynamics, has been only incompletely investigated in almost all the bat species. Brosset (1974) and Bradbury (1977) have admirably reviewed the current knowledge pertaining to the social organisation in chiropterans. The complex social behaviour and the variety of social organisations exhibited by bats are similar to those found in other highly social mammals. Whether such social organisation is manifested by Indian bats remains to be investigated. Males and females of some Indian bats have been reported to occupy separate sleeping quarters in the non-breeding season (Prater 1971). However, our knowledge of the social organisation in Indian bats is fragmentary. During an investigation on the reproductive cycle and associated phenomena in certain Indian bats (Krishna 1978, Krishna and Dominic 1978, 1981, 1982-a, b) some preliminary data were obtained pertaining to the social organisation and sex ratio of three species of bats. These are presented in this communication.

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Materials and Methods

Three species, the greater yellow bat, *Scotophilus heathi* (Family: Vespertilionidae), Indian sheath-tailed bat, *Taphozous longimanus* (Family: Emballonuridae) and short-nosed fruit bat, *Cynopterus sphinx* (Family: Pteropidae) are included in this study. The bats were trapped alive in the Banaras Hindu University campus and adjacent areas from September 1974 to October 1976. Most specimens were collected by using a gummed stick. Occasionally butterfly nets were also employed. *S. heathi* was obtained from the crevices on the walls of buildings. All the individuals (usually 2-6) in a roost were trapped on each occasion. Specimens of *T. longimanus* were collected from the hollows of trees. Each roost contained 20-30 individuals. Specimens of *C. sphinx* were collected from their roosting sites on palm trees (*Phoenix sylvestris* and *Borassus flabellifer*). The 20-40 individuals in a roost were huddled on the ventral side of the fronds.

On each visit effort was made to examine all roosting sites for bats. The numbers of adult males and females, and immature individuals present in each roosting site were noted. The pelage colour, body weight, wing span and histology of the gonads and accessory reproductive organs were the parameters employed for separating the adults from the juveniles (Krishna 1978). The sex ratios of adults and juveniles of each species were calculated from the total number of bats collected from all roosting sites.

Observations

Scotophilus heathi

Social organisation. The species is monoestrous, producing litter in July. Mating takes place from January to March (Krishna and Dominic 1981). Females and males have different roosting places except in the breeding season. In the breeding season, 2-6 females are found in association with a single adult male forming a harem. In January and February, a total of 50 such groups were found. After mating the sexes live together for sometime. Later the females aggregate in unisexual groups while males remain solitary. Parturition occurs in July (Krishna and Dominic 1981). The bond between the mother and young lasts for about two months after lactation. During this period also mature males remain in individual isolation. From November to early January both males and females are found in small unisexual groups of 2-6 adults.

Sex ratio. During the two years of random collection 130 adult females and 70 males were obtained. However, the sex ratio is almost even during the juvenile life. Out of the 26 young, 14 were females and 12 males.

Taphozous longimanus

Social organisation. The study of social organisation in *T. longimanus* is made difficult by the fact that it roosts in hollows of trees. Mixed groups consisting of 15-25 females and 5-10 males are found most of the time. Between October and June, 21 such groups were recorded. Segregation of sexes occurs during the non-breeding season (July to September) when the females roost in large unisexual colonies while males live in small unisexual groups.

Sex ratio. During the two years of random collection, 124 females and 56 males were obtained indicating an abnormal sex ratio. Out of 38 young collected, 20 were females and 18 males indicating an even sex ratio during juvenile life.

Cynopterus sphinx

Social organisation. The sexes remain segregated, except in the breeding season (October

to March) and in the winter months. During the winter both males and females congregate into large camps. In the breeding season groups comprising 6-10 males and 10-15 females are formed. Fifteen such groups were found during the period covered by the present study. Males remain with the females for sometime after mating. Later they segregate to form unisexual groups which persist throughout the non-breeding season (June to September). Ten separate colonies, consisting exclusively of either males or females were found from June to September.

Sex ratio. In contrast to *S. heathi* and *T. longimanus*, in *C. sphinx* the sex ratio is more balanced. Of the 203 adults collected, 112 were females and 91 males. The sex ratio is also even during the juvenile life.

Discussion

Even though detailed studies on social organisation have been made only in very few species, it is obvious that bats exhibit varied social organizations such as solitary life, promiscuity, grouping according to age, unisexual groups, monogamous, families, harem, the lek and interspecific groups (Brosset 1974, Bradbury 1977). Solitary species are not reported in bats though certain European rhinolophids and *Myotis* hibernate in isolation in caves. In promiscuous species, e.g. *Miniopterus schreibersii*, *Rhinolophus euryale*, males and females of all ages are seen in the same colony. Colonies of *Miniopterus schreibersii* comprising over 100,000 individuals are reported from India (Brosset 1962c) and of the American molassid, *Tadarida brasiliensis* exceeding even 20,000,000 individuals (Davis *et al.* 1962). Segregation of sexes, with monosexual groups at least during parts of the year, is reported in the Indian species, *Taphozous melanopogon*. In such species, males are invariably excluded from the "nurseries". In *Hipposideros caffer* and *Megaloglossus waermani*, during night individuals hunt for prey in unisexual groups (Brosset 1974). Monogamic families, though rare, are reported in *Kerivoula harrisoni* and *Agelena consociata* living in the equatorial forests of Africa (Brosset 1974). The megachiropteran species, *Hypsignathus monostrosus* exhibits a very peculiar social organization, *viz.* lek or arena mating (Allen *et al.* 1917). The males aggregate at night and make loud calls and females visit the singing assemblies ("leks") to mate (Bradbury 1977). Interspecific associations are reported between *Myotis emarginatus* and certain rhinolophids (Brosset 1974), though it is not known whether this is due to the occupation of the same niche by the two species or to any genuine attraction between the cohabiting species.

Harem as a social unit is typically found in tropical and neotropical species, e.g. *Myotis adversus* (Dwyer 1970), *Saccopteryx bilineata* (Bradbury and Emmons 1974), *Phyllostomus hastatus* and *P. discolar* (Rasweiler 1975), *Myotis boccagei* (Brosset 1976) and *Tylonycteris pachypus* and *T. robustula* (Medway and Marshall 1972). In several species harems are seasonally invariant social units. Olfactory signals are presumed to play an important role in the social integration in the harem (Bradbury 1969). In *S. heathi* harem formation occurs only in the breeding season (January and February). In general, the social organisation of *S. heathi* resembles that of *M. adversus* (Dwyer 1970). In both species, sexual segregation occurs between copulation and parturition and harem formation during the breeding season.

The social organisation of *T. longimanus* is similar to that of *S. heathi* in several respects. In contrast to the typical harem formation in *S. heathi*, in *T. longimanus* several males are

associated with a group of females in the breeding season. Furthermore, the females as well as males of this species segregate into unisexual groups during the nonbreeding season. This contrasts with the year-round multi-male/multi-female groups described in the neotropical emballonurids, *Saccopteryx leptura* (Bradbury 1977) and *Rhynchonycteris naso* (Dalquest 1957, Bradbury and Emmons 1974). In the tropical species, *Taphozous melanopogon,* mixed aggregations are formed at parturition with the females in the centre and the males in a concentric ring around them (Brosset 1962b).

The social organisation of *Cynopterus sphinx* resembles in certain respects that of *T. longimanus.* However, in *T. longimanus* the females in the breeding group far outnumber the males whereas in *C. sphinx* the groups are formed of more or less equal number of males and females. In several bat species, the sexes segregate soon after copulation and remain so at least up to parturition. This is especially true of the pteropids (Bradbury 1977). In the Australian species, *Pteropus poliocephalus,* Nelson (1965) noted unisexual groups between copulation and parturition and mixed groups during lactation. The sexes live apart for about two-thirds of the year. A similar organisation appears to operate in *P. gouldii* and *P. scapulatus* (Nelson 1965), *P. conspicillatus* (Ratcliffe 1932), *P. ornatus* (Sanborn and Nicholson 1950), *P. geddiei* and *P. eotinus* (Baker and Baker 1936). The social organisation in *C. sphinx* appears to be similar to that of the above-mentioned species. By contrast, *Pteropus giganteus* of India and Sri Lanka lives in permanent colonies with adults of both sexes (numbering occasionally over a thousand) present throughout the year (Neuweiler 1969).

In most chiropterans studied, even though the sex ratio is even among the juveniles it is uneven in the adults (cf. Gopalakrishna and Madhavan 1970, Bradbury 1977), with the females outnumbering the males; however, in *Taphozous melanopogon* and *Hipposideros lankadiva* (Abdulali 1947, *Megaderma spasma* (Brosset 1962b), *Hipposideros bicolar* (Brosset 1962b), *Eumops perotis* (Howell 1920) and tropical and temperate species of *Pipistrellus* (Davis 1966), the males outnumber the females. It is not clear whether this is due to a real excess of males in the population, or to the recording of all male groups or to other factors which has biased sampling.

The even sex ratio in the juveniles as seen in the three species in the present study is consistent with the findings in other chiropterans. The uneven sex ratio among adults favouring the females as seen in *S. heathi* and *T. longimanus* is true of most chiropterans. *C. sphinx* appears to be peculiar in that the adult sex ratio is almost even.

The differential use of environment and the existence of differential rates of maturation, mortality and longevity are some of the factors which contribute to the unequal sexual composition of bats. In species like *Megaderma lyra* (Ramaswamy 1961) and *Plecotus auritus* (Stebbings 1966), males mature earlier than females, whereas in *Macrotus waterhousii* (Bradshaw 1962) and *Tadarida brasiliensis* (Short 1961, Constantine 1967), the reverse is true. This may contribute to adding adults of one sex to the population faster and may also expose them to dangers of adult social behaviours earlier such as increased predation. The different maturation times of males and females may also influence the rate of mortality (Brosset 1966a, Barbour and Davis 1969).

According to Bradbury (1977), unequal sex ratios as seen in bats correlate with particular kinds of social systems. It is possible that the skewed sex ratios resulting in the excess of

one sex or another may result in a particular type of social organisation. In *S. heathi*, the sex ratio favours the females and the species is polygamous. This is also true of most molossids (Verschuren 1957). Harems in bats seem to exist in species where adult females outnumber adult males (Brosset 1976). However, harem formation in the true sense is not seen in *T. longimanus*, even though in this species the sex ratio favours the females. While unequal sex ratios seen in many bat species may tend to correlate with particular kinds of social systems, it is difficult to sort out the cause from the effect.

Acknowledgements

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STUDIES ON THE ACTIVITY PATTERNS OF THE LARVAE AND ADULTS OF *AEDES ALBOPICTUS* (SKUSE) AND *AEDES VITTATUS* (BIGOT) OF THE SCRUB JUNGLES OF PALGHAT-GAP, INDIA[1]

DAVID LIVINGSTONE AND K. KRISHNAMOORTHY[2]

(*With six graphs*)

In the Maruthamalai Scrub Jungles, *Aedes albopictus* and *Aedes vittatus* are the dominant species, the former breeding in tree holes and the latter in rock pools. The peak hours of activities of the adults and larvae of these two species vary considerably. Though their pupation time by and large determines the time of their adult emergence, their other activities are not predetermined. The relationship between their peak hours of adult emergence and the peak hours of their biting activity has been discussed.

INTRODUCTION

It is a well-established fact that both adults and immature stages of mosquitoes maintain a set pattern of activities at set times of either day or night. Gillett (1971) reported that this activity rhythm is not uniformly the same in all species. Aperiodic pupation and aperiodic emergence of adults in *Aedes aegypti*, as reported by Haddow *et al.* (1959), have been considered as significant complementary factors in determining the vector role of these mosquitoes. The pupation rhythms in *Aedes taeniorhynchus* (Nielson and Haeger 1954, Nielson and Evans 1960, Nayar 1967 and Provost and Lum 1967) and *Anopheles gambiae* (Jones and Reiter 1975) have been documented and the mechanisms that operate the eclosion timing in *A. gambiae* (Reiter and Jones 1975) and pupation periodicity in *Ae. vittatus* (Service 1970) have been partially known. But, while most of the reports deal with the feeding and oviposition activities of the imago of various species, much less information is documented on the activity rhythms of the immature stages and their consequent impact on the behaviour of the imago. Therefore, an attempt is made here to fill certain prevailing lacunae in this area of mosquito research. *Aedes albopictus* and *Ae. vittatus* have been chosen, the former breeding in tree holes and the latter in rock pools, rock crevices and rock holes in the scrub jungles of Maruthamalai hills of the Palghat-Gap.

MATERIALS AND METHODS

Colonies of *Aedes albopictus* and *Ae. vittatus* were maintained in the laboratory. Eggs collected from the colonies were allowed to hatch in separate rearing vials (7.5 cm × 2.5 cm) under room temperature (26°C-30°C) and humidity (59% at 7.22 hrs and 90% at 14.22 hrs). Along with the eggs in each vial, about 5 mg of yeast was added, for the purpose of hatching, since bacterial stimulus is known to be an essential requirement for

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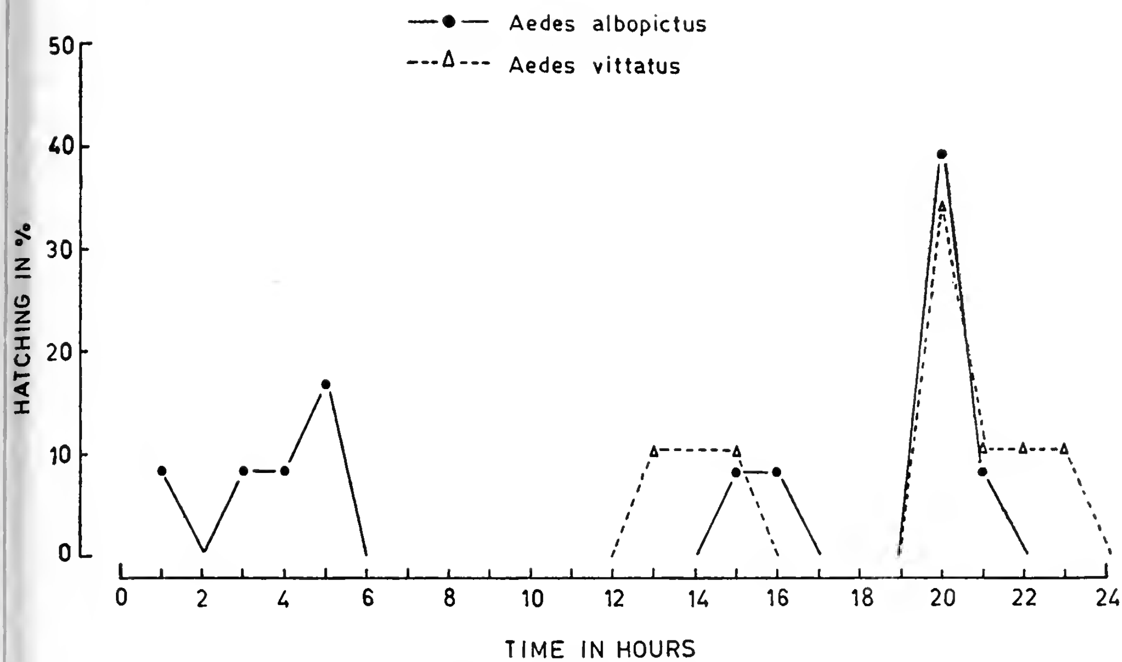
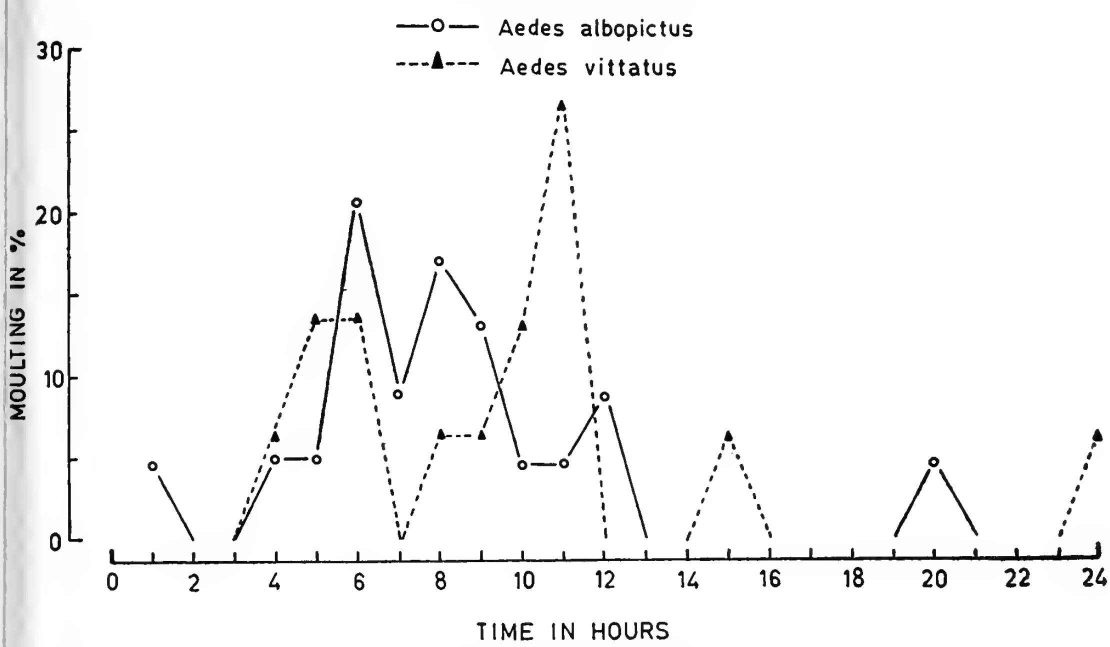


Graph 1. Hatching rhythm.



Graph 2. Moulting rhythm.

eclosion. Observations were recorded at hourly intervals and the larval and pupal castings were removed periodically in order to protect the life stages from contamination. Fresh yeast was provided daily with the changing of water. The time of sunrise and sunset were recorded at 5.42 hrs and 18.29 hrs. respectively, each day.

Results and discussion

a) **Hatching rhythm.** The minimum period of incubation has been recorded at 96-97 hours in *Aedes albopictus* and *Ae. vittatus.* After the hatching of the first batch of eggs, it is found that the hatching time of the subsequent batches depends on the stage of advancement of respective embryos as well as the grade of intensity of hatching response, as reported by Gillett (1955). Though the eggs do hatch during night and day in both species, a distinct peak has been registered at 19 and 20 hrs (Graph 1). It is interesting to report here that these two peak hours of hatching exactly coincide with the peak hours of their oviposition. If the breeding habitats are not readily accessible, they retain the eggs for a few days and if favourable conditions are not restored within the stipulated period, they perish without releasing the eggs. This behaviour, however, is not time bound, as the eggs are deposited at any time of the day or night whenever moisture is found available on the substratum. It is also found that these two species, unlike as observed in a few species of *Anopheles,* never deposit their eggs in dry substratum and they do not show any manner of gonadotropic dissociation.

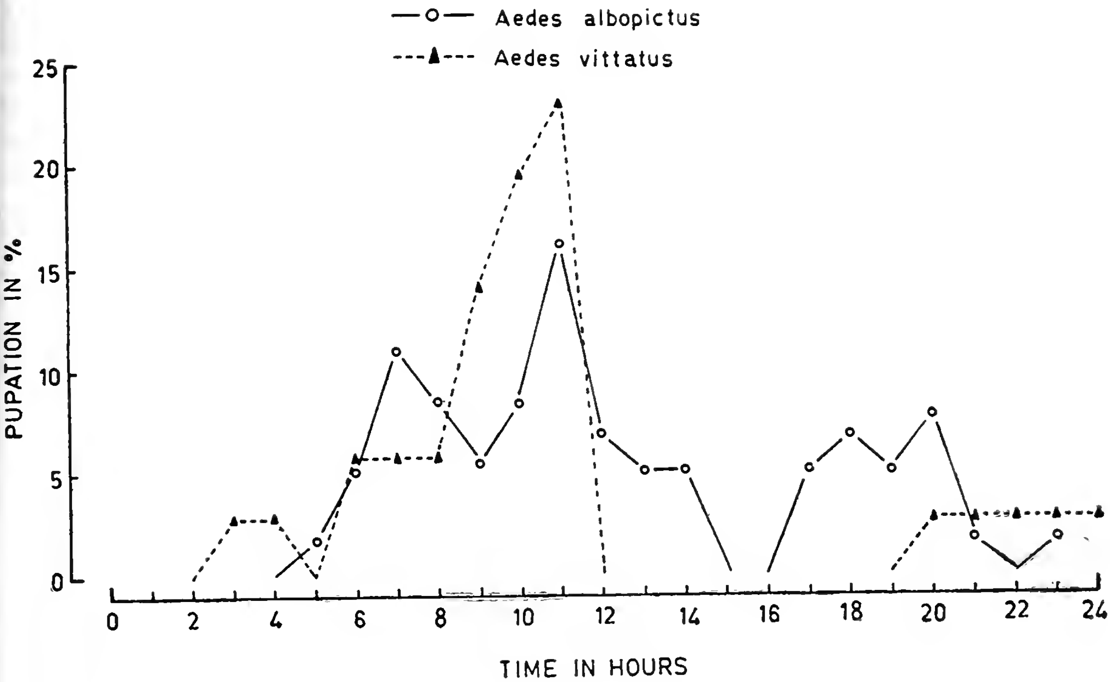
During the peak hours of hatching, larvae of both males and females hatch almost simultaneously in equal numbers. Qutubuddin (1954) however, has reported that in *Culex pipiens fatigans* the males hatch earlier than the females.

b) **Moulting rhythm.** Though the moulting timings of all the three instars of both *Ae. albopictus* and *Ae. vittatus* are not quite uniformly paced, the daily maxima in the former has been recorded at 5 and 6 hours and that of the latter at 10 and 11 hrs (graph 2). In *Ae. albopictus,* the larval period ranges from 115 to 141 hrs for the males and 119 to 149 hrs for the females. In *Ae. vittatus,* the larval period for males is 103 to 135 hours and for the females 112 to 143 hrs. (Table 1). According to Service (1970), the relatively longer larval period of the females is due to their slower rate of development. In the present investigation, the rate of development of the females in both species is comparable with

Table 1

Larval period in hours in *Ae. albopictus* and *Ae. vittatus*

Species		Larval Instars I	II	III	IV	Total
Ae. albopictus	Male	20-32	25-30	24-30	46-49	115-141
	Female	20-32	25-30	24-30	50-56	119-148
Ae. vittatus	Male	19-26	19-29	20-28	45-52	103-135
	Female	19-26	19-29	20-28	54-60	112-143



Graph 3. Pupation rhythm.

those of *Aedes taeniorhynchus* (Nielson and Haeger 1954) and *Aedes aegypti* (Christophers 1960).

c). **Pupation rhythm**. The pupation timings are not evenly paced during the 24 hr. period, though there is a distinct maximum at certain hours of the day. In *Ae. albopictus*, the maximum pupation of the female larvae occurs between 10 and 11 hours without any coincidence with its moulting peaks (Graph 3), whereas in the males, the pupation occurs throughout the day, almost without any peak to record as the daily maximum. Such a phenomenon appears to be uncommon among other species of mosquitoes.

In *Ae. vittatus*, however, there exists a daily peak between 10 to 11 hours and the peak significantly corresponds with the peak of its moulting activity (Graphs 2 & 3). Service (1970) reported a peak of pupation activity in this species in Northern Nigeria between 24 and 01 hours and according to Gillett (1971) such behavioural variations could be attributed to the prevailing geographic as well as microclimatic variations. Nielson and Haeger (1954) and Reiter and Jones (1975) however, have not reported such a pattern of pupation in *Ae. taeniorhynchus* and *Anopheles gambiae* respectively.

Table 2 indicates that in both *Ae. albopictus* and *Ae. vittatus*, the duration of pupal period is more for the females and that in the former species this period is much more prolonged than in the latter.

However, the pupal period of *Ae. vittatus* in this biotope is found to be less than that recorded by Service (1970) for the same species in Northern Nigeria (44.8 hrs and 45.00 hrs

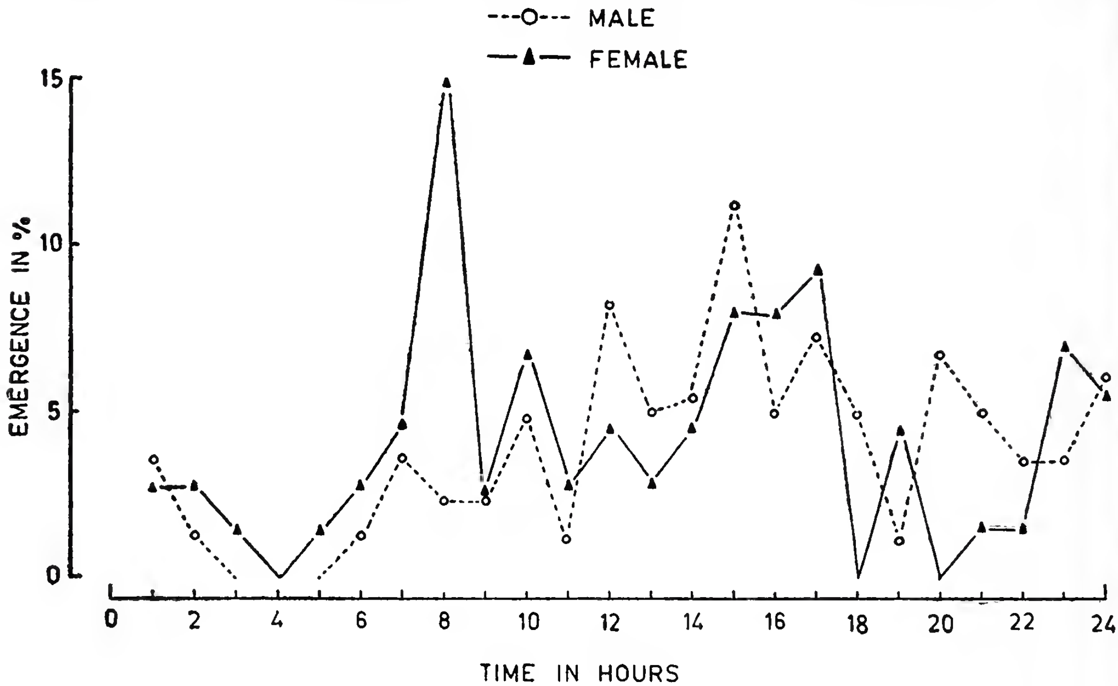
TABLE 2

DURATION OF PUPAL PERIOD IN *Ae. albopictus* AND IN *Ae. vittatus* UNDER LIGHT AND DARK (IN HOURS) CONDITIONS

Species		Light	Dark	Control
Ae. albopictus	Male	17-24	12-14	31-36
	Female	26-28	24 hours	49-52
Ae. vittatus	Male	17-21	12	39-43
	Female	20-21	12	42-43

is 12 to 16 hrs less than that of the females, in *Ae. vittatus* the difference is almost always negligible (1 to 3 hrs). Such significant difference in the pupal periods of both sexes in *Ae. albopictus* accounts for the arhythmic pupation and emergence of males in this species, as mentioned earlier. In *Ae. vittatus*, this difference is very narrow.

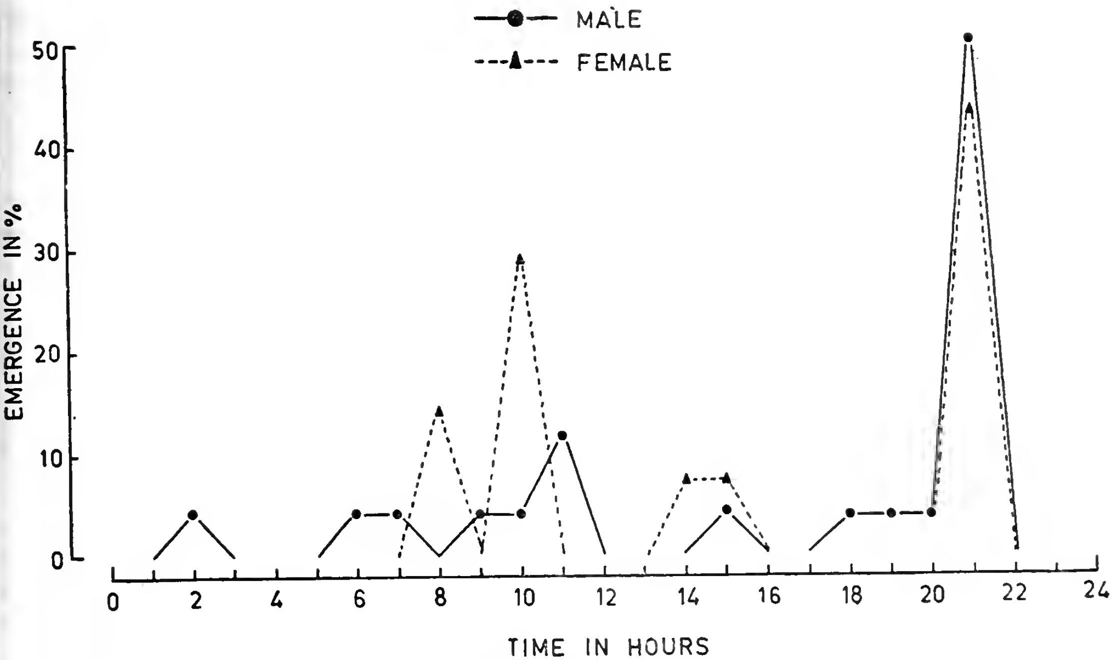
When the pupae are exposed to continuous light, the pupal period is reduced to 17 to 24 hrs for males and 26 to 28 hours for females in the case of *Ae. albopictus* and 17 to 21



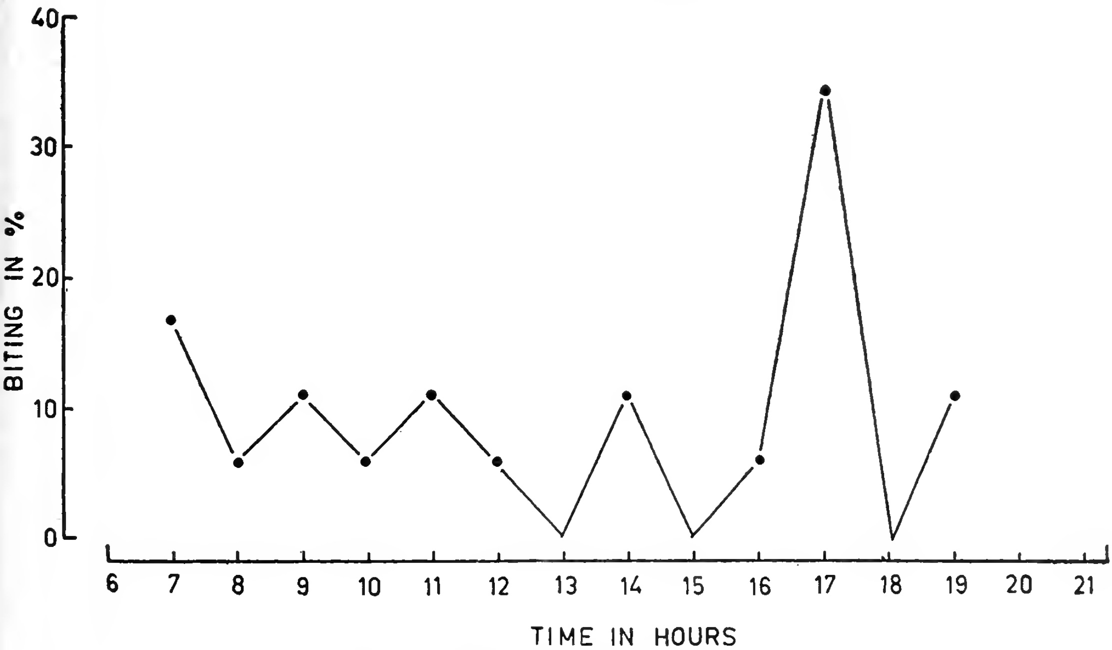
Graph 4. Emergence rhythm in *Aedes albopictus*.

for males and females respectively). Thus the present observations provide additional evidence of behavioural variations that are regulated by geographic and climatic variations, a view advanced by Gillett (1971). It is also interesting to report here that while in *Ae. albopictus*, the pupal period of the males

hours for males and 20-21 hours for females in the case of *Ae. vittatus.* When the pupae are exposed to continuous darkness, the pupal period is reduced to 12 to 14 hrs for males and 24 hrs for females in *Ae. albopictus* whereas in *Ae. vittatus* the duration of pupal period in both sexes in



Graph 5. Emergence rhythm in *Aedes vittatus*.



Graph 6. Biting rhythm in *Aedes albopictus*.

darkness remains the same (12 hrs). The longer duration of the pupal period of female *Ae. albopictus*, even under experimental conditions, further suggests that these pupae need to be subjected to a minimum period of 24 hrs of darkness to complete their development. In *Ae. vittatus*, however, darkness has significant effect on the development in both sexes.

Since the pupal period in both species under control conditions as well as when exposed continuously to light, is longer for the females, it may suggest that developmental rate of the female is slower than the males, a view advanced by Nielson and Haeger (1954) in the case of *Ae. taeniorhynchus.* However, the rate of development of females in the case of *Ae. vittatus* appears to have been accelerated by darkness, the biological reasons for which are difficult to explain at this stage.

d) **Adult emergence rhythm**. In the females, in both species, the peak of adult emergence activity appears at certain fixed time of the day. In the males this appears to be quite erratic.

In *Ae. albopictus*, the females emerge between 7 and 8 hours and therefore rhythmic. But the males do not maintain a peak hour of emergence and therefore arhythmic (Graph 4). The rhythm in the emergence of females in this species can be readily correlated with the peak hour of biting activity, as observed in the field (Graph 6). In the laboratory, it is found that a female requires a minimum period of four hours of rest, following emergence, before it is ready to take its first blood meal. The peak of its emergence occurring at 8 hours therefore is responsible for its peak of biting activity at 16 or 17 hours, leaving an interval of approximately 8 hours between emergence and first blood meal.

In *Ae. vittatus*, the males and females emerge rhythmically, at the same time the adult emergence peak occurring at 20-21 hrs. (table 3 and Graph 5). The biting activity

TABLE 3

PUPATION TIME IN *Ae. albopictus* AND *Ae. vittatus*

Species		Time of Pupation	Time of Emergence
Ae. albopictus	Male	Arhythmic	Arhythmic
	Female	10-11 AM	7- 8 AM
Ae. vittatus	Male	11-12 AM	20-21 PM
	Female	9-10 AM	20-21 PM

of this species could not be studied in this biotope and Service (1970) reported its peak hour of biting activity as 20-21 hrs in Northern Nigeria. However, since other biological rhythms of this species reported by Service are not in conformity with the observations made in this biotope, it is not probable that the same time of biting activity is maintained by it in this biotope too.

e) **Determination of rhythms.** In the two species it has been found that the larvae that hatch at different times of the day moult almost simultaneously at the peak hour of moulting activity and the range of larval period does not remain constant. Thus it is clear that the time of hatching does not have any influence on the moulting activity and the larval moulting does not influence pupation. The pupation rhythm is also found to be not predetermined. The rate of larval development plays a more important role in the pupation activity than the time of moulting itself.

Pupation follows a rhythm and the pupation period ranges from 1 to 5 hours in both *Ae. albopictus* and *Ae. vittatus.* Therefore, the rate of development during pupation

appears to be almost constant. Thus the present studies confirm the suggestion of Nielson and Haeger (1954) and Nayar (1957) that the time of adult emergence is predetermined by the time of pupation which in turn is not determined by the time of larval moulting.

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INSECTIVORY BY GREY LANGURS[1]

JIM MOORE[2]

During a field study of langur all-male bands, I observed 5 episodes of active insect predation, whereas previous langur watchers have reported only occasional instances of langurs feeding on non-mobile prey (insect pupae, bird eggs, etc.). If this difference is real, it may represent a sex difference in food needs or it may be a reflection of restriction of male bands to "suboptimal" habitats. Data on these observations is presented, together with a discussion of incidental insectivory in the course of eating figs. I conclude that insect-eating by langurs is best explained by an energy/nutrient maximization model, rather than as a consequence of any special characteristic of meat itself.

INTRODUCTION

Despite numerous field studies, there are very few reports of "meat" eating by grey langurs (*Presbytis entellus*) (Roonwal & Mohnot 1977). On one occasion, Yoshiba (1968) saw langurs at Dharwar feeding on caterpillars, and they infrequently fed on insect galls from the leaves of *Terminalia tomentosa.* While surveying the langurs of the Gir Forest, Rahaman (1973) observed one case of langurs eating bird eggs, and states that they ate pupae found on leaves. In addition, Hladik (1977a) has pointed out that *P. entellus* undoubtedly ingests a number of insects while feeding on figs, although he apparently does not consider them a significant part of the diet.

During a long term study of langur all-male bands (AMBs) in Rajasthan, I observed several cases of deliberate predation on insects. These are presented below along with some information on the possible dietary significance of insects to the langurs studied.

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METHODS

This paper is based on approximately 950 hours of observation on langur male bands at Mt. Abu and Ranthambhore Tiger Sanctuary, both in Rajasthan, India. Groups at Mt. Abu were studied from September 1979 to April 1980, and at Ranthambhore from mid-April to mid-June 1980. The langurs were habituated to observers and all observations were made on foot at distances of 3 to 20 metres from the animals. The langurs' behaviour was recorded using focal, scan, and extensive *ad lib.* sampling; most of the insect predations observed occurred during *ad lib.* sampling periods.

Mt Abu is the highest point between the Himalayas and the Nilgiris, and consequently enjoys greater and more evenly distributed rainfall than the surrounding semi-desert (Mehta 1979). The langurs studied live on the edge of the town of Mt Abu and in the surrounding Forest Reserve; the habitat here is primarily subtropical evergreen forest (Jain 1967). Ranthambhore lies in the low hills of the northern Aravallis and the habitat is highly seasonal, with almost 90% of the annual rain falling during July through September (Khullar,

n. d.; compare to *c* 50% for the same period at Mt Abu, from Mehta 1979 Fig. 2). The forest at Ranthambhore is dry deciduous *Anogeissus pendula* and *Acacia catechu*, with scattered evergreens near waterholes and in the seasonal nullahs (Mathur 1979).

Cases of insect-eating

Grasshoppers (Abu)

Note. I did not obtain any specimens. At least two distinct types were taken — a bright green, large-winged one, and a stockier brown one with reddish markings on the leg joints. All individuals chased or eaten were large, more than 2 inches long (despite the presence of many smaller ones).

1) Oct. 23, 1979. All *ad lib.;* rainy day.

1354 PT (small juvenile male) pounces on a large green grasshopper, jumping about 50 cm from a resting position in a *Ficus religiosa* tree. He grabs it, holds it in both hands by the back and with some hesitation over the legs he eats the whole insect. It is about 3 inches long and takes him about 1 minute to eat.

2) Oct. 29, 1979. *Ad lib.*

0832 MS (large infant male) chases a grasshopper; it escapes.
D2 (large juvenile male) and then FR (adult male), each cuing on the actions of the preceding monkey, watch the insect's flight and try to catch it as it lands; both miss. FR came jogging from about 10 m away. In all three cases the grasshopper took wing before the monkey got within 1 m.

3) Nov. 24, 1979. *Ad lib.*

1558 Large grasshopper lands about one-half metre from PT; he tenses, pounces and misses and it flies away.

4) Dec. 2, 1979. During focal observations on EA, a large juvenile male. Observations began at 1603; EA feed/forage on leaves for the first 12 minutes.

1615 EA resting, eyes open, scratches. 1615:58 he suddenly grabs a large brown grasshopper and immediately begins eating, starting with the abdomen. He continues chewing until 1618:30, finishing the entire insect.

1619 EA begins eating a stalk of *Euphorbia* sp., continues eating it until 1622.

1621 A large grasshopper flies past and EA watches it, conspicuously orienting toward it. It lands near by and PT jumps at it but misses. Note — PT had watched EA eat his.

1624 EA jumps at another grasshopper, but misses.

1627 JH (young adult male) tries for one but misses; Note — I do not know if JH was in sight when EA ate his.

1636 MS (large infant male) tries for and misses another (same?) grasshopper.

Termites (Ranthambhore)

5) June 26, 1980. The morning after the first heavy rain of the monsoon. Termite alates are out in force, and it seems like more than one nest — certainly more than one exit. Specimens of the alates were later identified by M. L. Roonwal as *Odontotermes flavomaculatus.* Observations began before 0600; the monkeys spent the first 30 minutes of the day feeding on ripe fruit of *Diospyros melanoxylon.* I am with 6 young adult males of the "DS" band.

0638 MR vigilant, scratches; then grabs and eats a termite from the ground. He then takes several flying ones and apparently begins to try to trace them to the nest exit. Neither he nor I succeed, but he continues to eat them, preferring flying ones.

0641 MR feeds briefly on young *Anogeissus pendula* leaves, then resumes feeding on termites.

0643 MR continues feeding; note that his nearest neighbour is more than 25 m away.

0644 RS comes near enough that he must be aware of the termites, but shows no reaction to them. MR slows down his feeding.

0647 RS starts to feed on the termites, and several others have by now arrived and they join in.

Up to now, it seems that none of the monkeys have eaten more than about 15-30 termites; MR was eating about 5/minute at most for just over 6 minutes and he did not seem especially interested in them (i.e., he did not eat as many as were readily available).

0700 We come across more termites as the group works its way along a nullah. Most of the 6 feed on them, preferring flying ones. Feeding is more intensive, and I estimate they eat about 50/individual. MR and RS are the most active, and MR (the alpha in this group) displaces RS to take a flying termite.

It is probably unrelated but worth noting that this male group initiated a takeover attempt and successfully seized a nearby bisexual troop at about 0945 this morning.

Cecidomyiid fly larvae (Abu)

6) Nov. 14, 1979. At 1608, the old male Harelip moved into a backyard garden and began eating unripe *Ficus* (*palmata*?) at an unusually fast rate, feeding continuously for 17 minutes. Unripe figs were rarely eaten by

Table 1

Insects eaten by langurs

	Dry weight per unit	Number units consumed/time	Estimated insect intake (dry weight)	Composition (% dry wt.)[3] Protein	Lipids
Grasshoppers	—	2/900 + hours	—	55	15[4]
Cecidomyiid maggots	.042 g/fig (1 fig)	200 figs/17 minutes (11 of 17 infested)	*F.* (*palmata*?) rare; *c.* 5 g/100 hours[1]	62	21[5]
Fig wasps	.0068 g/fig ($\bar{Y}$ of 3 figs)	figs *c.* 15% of diet (AMBCB, March 1980)	2 - 20 g/100 hours[2]	29	4[6]
Odontotermes alates	.037 g each ($\bar{Y}$ of 2)	*c.* 75 in one morning	to *c.* 3 g/bout *rarely* available	— / 36	48[7] / 44[8]

[1] Where available; this fig is found primarily in cultivated areas at Abu.

[2] The actual weight consumed depends on when the fig is eaten (see text). Among Agaonid wasps, 10f: 1m sex ratios are standard (see Hamilton 1967); following emergence of the alate females the wasp biomass/fig is reduced by a factor of about 10.

[3] Based primarily on measurements for other species in other locations, *approximations* only.

[4] Value for *Locusta migratoides*, International Institute for African Languages and Culture 1937.

[5] Value for "caterpillars", Hladik 1977b.

[6] Value for the ant *Macromiscoides aculeatus*, Hladik 1977b.

[7] Value for *Odontortermes assmuthi*, Basalingappa 1970.

[8] Value for unid. African termite alates, Tihon 1946 (cited in Wood and Sands 1978).

these langurs and so I examined some of them; 11 of 17 contained massive infestations of maggots. These were later identified by N. Woodley as being cecidomyiids (Diptera).

Dietary significance

Samples of termite alates (in formalin), fig maggots and fig wasps (both in alcohol) were taken and later weighed after freeze-drying to constant weight. These dry weights are given in Table 1, together with the estimated total intake (dry weight) of each insect type by the monkeys. The langurs ate grasshoppers, maggots and termites very rarely and these certainly had a negligible energetic impact on the monkeys. The estimated calorific value for termites is about 31.3 kJ/g (dry weight) (Wood & Sands 1978); thus the Ranthambhore males obtained approximately 22 kcal each from their morning's excursion into predation — less than 3% of their daily energy requirement (based on Parra 1978, T. 10).

Fig wasps (mostly symbiotic Agaonidae, with some parasitic species also) are the only insects that were regularly consumed by the langurs. Are the monkeys deliberately eating them? It is hard to measure selection for wasp containing figs directly, since only figs *not* eaten are available for examination. It is possible to gather indirect evidence, though, by comparing the proportion of wasp-containing figs on branches where langurs have fed to that on branches that have not been fed upon.

When the wasps mature, they burrow through the wall of the syconium and the alates (which make up the greater part of the wasp biomass) leave the fig (see Wiebes 1976, 1979). The hole left by the wasps is easy to see and its presence or absence is a good indicator of presence/absence of significant numbers of alate wasps in the fig (*personal observation*). About 80% of the figs eaten by the "CB" band at Abu were of *Ficus* (*virens*?). I examined figs from three areas of a single *F.* (*virens*?) after the "CB" group had finished feeding in the tree, on their first visit to it during that fruiting period. The three areas were:

1) a patch skipped over by CT, an adult, as he foraged (no other langurs entered it that morning);
2) a patch in which CT fed for several minutes before shifting to another feeding site; and
3) a patch near where the alpha male, FR, had fed; because other males avoided feeding near FR, this patch hopefully represents the baseline, unforaged distribution of figs.

Three or more separate stems were examined from each area, and figs were scored for presence/absence of a hole near the ostiole and for being hard or soft to the touch (soft figs are "ripe", i.e. come easily from the stem and do not drip latex sap when plucked; *F.* (*virens*?) figs did not change colour noticeably as they matured).

The results are presented in Table 2, and suggest that these langurs were choosing ripe figs, not wasp-containing ones. Since all ripe figs examined had wasp emergence holes, preference for ripe figs means the monkeys are actually consuming much *less* wasp than indicated in Table 1. Evidently avoidance of

Table 2

Fig choice

	Hole	No hole	Hard	Soft
1) Skipped	28	11	34	5
2) Fed in	34	14	39	9
3) Baseline	62	17	50	29
	$X^2 = 1.17$, 2f., N.S.		$X^2 = 9.49$, $p < .01$	

NOTE: "Hole" = wasps emerged; "No hole" = wasps contained; "Hard" = unripe (latex present); "Soft" = ripe (latex absent).

secondary compounds in the latex sap and/or selection for increased sugars associated with ripeness (Janzen 1979) is more important to the langurs than is the animal protein available from the wasps. It is interesting to note that this balance was evidently tipped the other way in *Case* 6, in which Harelip fed extensively on unripe *Ficus* (*palmata*?) infested with cecidomyiid fly maggots. In that case, the average fig contained approximately 0.03 g dry weight of insect (60% infested × 0.042 g/infested fig), *versus* 0.007 g dry weight/fig of fig wasps. The fourfold increase in available insect matter per fig seems to have made coping with the latex worthwhile. (It is possible, of course, that chemical differences between the different *Ficus* species and/or differing nutritional states of the langurs were also involved).

Discussion

Although langurs have been studied at numerous locations in India, Nepal and Sri Lanka, predation on large, active insects such as grasshoppers and termite alates has not been previously reported. During this research, such predation was observed at two ecologically distinct sites. Though the total number of cases is small, it is interesting to speculate that this higher incidence is a real phenomenon, related to the fact that I was following all-male bands while previous workers have focussed almost exclusively on bisexual troops (see Hrdy 1977, Bishop 1979, Roonwal & Mohnot 1977). This suggests two possible explanations. The first is that males need meat/insects more than do females (cf. Hausfater 1976), and since bisexual troops are predominantly female the occasional cases of insect predation by troop males simply have been missed. However, growing juvenile males may be even more prone to insectivory than adults (Aldrich-Blake 1980, p. 163), and both successful grasshopper predations observed during this study were by juveniles. If studies of bisexual troops have been observationally biased against juvenile males, the higher frequency I observed could be due to sampling bias. In this case, we may conclude that there really is a sex difference in insectivory for this species. The second, and perhaps more interesting, alternative comes from the observation that AMBs are actively excluded from optimal foraging areas by the bisexual troops (Sugiyama *et al.* 1965, *personal observation*). It is possible that AMBs in these "suboptimal" areas are compensating for the absence of some nutrient readily available to the bisexual troops by an increased intake of insect prey. I consider this second explanation more complex and so less likely; more studies of feeding by males in both bisexual troops and AMBs are needed to resolve the question.

After this paper was submitted, R. S. Pirta very kindly provided me with his unpublished observations of female *P. entellus* feeding on unidentified caterpillars and occasionally hunting for and eating grasshoppers at Khandagiri (Orissa). It may be that insect predation by females has been under-reported in the literature; alternatively, Khandagiri may be suboptimal langur habitat (R. S. Pirta, *personal communication*). More fieldwork is clearly needed.

An interesting feature of several of the grasshopper hunting episodes is that following a first apparently spontaneous attempt by one individual, several other males began actively hunting. These clusters of hunting events could not be explained by spatial or temporal variations in grasshopper density or behaviour. The pattern is very similar to that described for chimpanzees preying on vertebrates — after weeks or months with no hunts, a success-

ful kill would initiate a period of active hunting that would then wane over a period of weeks (van Lawick-Goodall 1971). Among male langurs, the active period is compressed from weeks to minutes, but in both cases it implies a social as well as nutritional component to the hunt.

Finally, the obvious question: why do these langurs prey on insects? Three general hypotheses have been suggested to explain meat and insect eating in otherwise herbivorous primates (see Hamilton & Busse 1978).

MICRONUTRIENTS. Hausfater (1976) speculates that Amboseli baboons may be eating meat in order to obtain vitamin B12, an essential vitamin not available from most plant foods. While this idea may be applicable to baboons and other cercopithecines, colobines seem to be able to utilize vitamin B12 produced by bacteria in their specialized stomachs (Oxnard 1966). Some micronutrient other than B12 may be critical for colobines; to my knowledge none has been suggested, and this hypothesis can be tentatively rejected.

HIGH-QUALITY PROTEIN. Because animal protein is both more digestible and a more balanced source of amino acids for primates, it has been suggested that meat-eating provides individuals with necessary high-quality protein (Dart 1963, cited in Hamilton & Busse 1978). Given the small quantity of insects normally consumed in figs and the rarity of deliberate insect predation by langurs (and its absence in females?), high-quality protein cannot be a requirement for these monkeys. It may however be a better-than-average protein source; see below.

ENERGY/NUTRIENT MAXIMIZATION. Animals should, in theory, attempt to maximize their net intake of energy and optimize intake of essential nutrients (Schoener 1971). Predation usually involves high costs (e.g. searching, chasing) for high benefits (animal matter is high in energy and nutrients) (Gaulin & Kurland 1976). Most reported langur insectivory has been on slow-moving (maggots, caterpillars, pupae) or superabundant (termite alates) prey. Only two out of ten attempts at grasshoppers were successful, and both were by resting monkeys who opportunistically seized the insect. Together with the sporadic occurrence of langur insect-eating, these observations support the energy/nutrient hypothesis. Animal matter is not necessary for langurs, but does represent an acceptable, and perhaps favoured, alternative food when it is easily obtained. Whether or not this conclusion can be applied to non-colobines depends on more detailed testing of the competing hypotheses.

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ECOLOGICAL INTERACTIONS BETWEEN MISTLETOES AND THEIR AVIAN POLLINATORS IN SOUTH INDIA[1]

PRIYA DAVIDAR[2]

(*With two text-figures*)

Seven species of mistletoes (Loranthaceae) in the Nilgiris were pollinated by four species of birds, the flowerpecker, white-eye, small sunbird and the purple sunbird species, belonging to three families (Dicaeidae, Nectariniidae and Zosteropidae). Individual birds and the plants were mutually adapted to a degree that limited flexible utilisation of other sources for nectar. Interference competition was more intra- rather than interspecific. These data suggest that interspecific competition is not an organising force in this system, unlike communities in the neotropics and in East Africa. Independent coevolution between pollinators and the species of plants they pollinate seems a more plausible alternative. I suggest that selection against hybridisation as well as host and microhabitat preferences of the mistletoes might have been important in determining these interactions over evolutionary time.

INTRODUCTION

Studies on tropical nectar feeding birds have suggested that inter-specific competition for nectar is responsible for the organisation of bird communities (Colwell 1973, Feinsinger 1976, Gill and Wolf 1975, Wolf, Stiles and Reed Hainsworth 1976). The foraging efficiency of particular bird species and their relative success at excluding less efficient bird species from nectar sources is thought to form the organising base for hummingbird communities (Feinsinger 1976, Feinsinger and Colwell 1978, Wolf, Stiles and Reed Hainsworth 1976), and consequently considered to effect the pollination strategies of plants (Feinsinger 1976, Stiles 1975). This study examines the relationships among seven species of montane mistletoes (Loranthaceae) in the Nilgiris, southern India, and four species of nectar feeding birds belonging to three families (Dicaeidae, Nectariniidae and Zosteropidae). This system appears to be similar in different regions in the Indian subcontinent, although the mistletoes and bird species that form the community differ (Ali 1931, Kannan 1966, *personal observation*). This study investigates three aspects: 1) the birds' food and habit preferences; 2) the mistletoes' host preferences, floral morphology, nectar secretion patterns and pollination characteristics; 3) and finally the foraging patterns, territoriality and dominance interactions of birds at nectar sources, and the effects of these aspects of bird behaviour on flower pollination.

STUDY AREA

The study area, the Nilgiris, lies between latitude 11° 12′ and 11° 43′ N and longitude 76°14′ and 77° 1′ E. The Nilgiris is composed of an upper plateau of average height 2000 m and a lower plateau of about 1000 m.

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The study area included montane forests, secondary vegetation and cultivated areas at about 1800 m elevation on the eastern portion of the upper plateau. The montane forest is commonly known as a 'shola' and supports a diversified tropical flora and fauna with notable endemic and Indo-Malayan elements (Champion and Seth 1968).

Climate

The monsoons play an important part in the climate of this area. The effect of the monsoons is modified by elevation and topography (Lengerke 1977). The Nilgiris receives rainfall from both the NE and SW monsoon winds. There is a decrease in rainfall from west to east. The Kundah range in the west receives more than 5000 mm rainfall annually on average, whereas some areas on the north-eastern lower slopes receive less than 500 mm. Dry months are January, February and March.

Methods and Materials

Four study sites were chosen. Transects marked through the study sites were 250 m long in Sims Park shola, 100 m long in Wellington shola, 250 m long in the disturbed habitat and 500 m long in the horticultural park (Sims Park).

Four species of birds visited mistletoe flowers for nectar : the plain coloured flowerpecker (*Dicaeum concolor* Jerdon) of the Dicaeidae, the small sunbird [*Nectarinia minima* (Sykes)], the purple sunbird [*Nectarinia asiatica* (Latham)], both of the family Nectariniidae, and the white-eye [*Zosterops palpebrosa* (Temminck)] of the family Zosteropidae.

The purple sunbird and the white-eye are widely distributed in the Indian subcontinent. The small sunbird and the local subspecies of the plain coloured flowerpecker occur only in the higher altitudes of the Western Ghats (Ali and Ripley 1974).

Relative abundances of nectar feeding birds were approximated by recording them about 5 m to the left and right of me while walking through the transect at a particular hour (8 a.m. to 10.30 a.m.). These censuses were carried out once every two weeks. The birds were recorded by species and sex. When recorded by vocalisation alone, only the species was noted. When sighted, the activity at the moment of sighting was recorded. If feeding, the type of food taken and feeding level in relation to the surrounding vegetation was recorded. Birds were captured in the sites in mist nets and marked with colour bands on their tarsus for future identification.

Ecology of the Plants

Seven species of mistletoes (Loranthaceae) occur in the study area. They are *Helixanthera intermedia* (Wt.) Danser, *Taxillus recurvus* (DC.) van Tieghem, *Taxillus cuneatus* (Roth) Danser, *Dendrophthoe neelgherrensis* (Wt. & Arn.) van Tieghem, *Dendrophthoe memecylifolia* (Wt. & Arn.) Danser, *Dendrophthoe falcata* (Linn. f.) Etting and *Macrosolen parasiticus* (Linn.) Danser. Two species *Taxillus recurvus* and *Dendrophthoe memecylifolia* are endemic to the Nilgiris. *Dendrophthoe falcata* is widely distributed in the Indian subcontinent. The other four species are distributed in the higher altitudes of the Western Ghats and a few occur in Sri Lanka as well (Hooker 1890, Fyson 1932, Gamble and Fischer 1967).

General observations were made on host plant preferences of mistletoes in different habitats. All mistletoe plants in the study sites were recorded and tagged. The number of flowers produced by these plants were recorded once every two weeks. Individual flowers are open for 2 days. In species where the flowers were produced in compact masses, about 1 sq. m. of ground under the plant was

cleared of all debris, and the numbers of fallen flowers, corolla tubes, buds, epicarps and fruits were recorded 24 hours later. In species where flowers were produced in diffuse masses, the number of flowering inflorescences was counted. Flowering times of two species — *Taxillus recurvus* and *Macrosolen parasiticus* — were recorded from observations elsewhere or in adjacent areas.

Nectar secretion patterns were recorded by enclosing flowers in mosquito mesh bags and measuring the accumulated nectar. The flowers were re-enclosed and the nectar re-measured at hourly intervals. This measurement was started in the morning and continued for the rest of the day. A syringe graduated to 0.1 ml was used. Due to the imprecision of the method only relative values could be obtained. In species where the bud does not open without external manipulation the nectar was measured in manually opened flowers, the flowers were re-enclosed and the nectar was measured thereafter at hourly intervals.

Observations were made on individual plants of each species to determine the number and species of birds visiting flowers for nectar. The number of flowers visited per foraging bout, and the revisitation rates of individual birds to the same plant were recorded. Behavioural interactions between birds at flowering mistletoe plants were recorded.

To determine the importance of birds in pollinating the flowers, some experiments on seed set with and without birds were carried out. Species were tested for autogamy by enclosing inflorescences in mosquito netting to exclude birds and insects. Fruit set was noted. Chicken wire mesh bags were also used to exclude birds but not insects and fruit set was noted. Fruit set in open pollinated flowers was recorded.

RESULTS AND DISCUSSION

Morphology and Distribution of the Birds

The white eye is the heaviest species, followed by the purple sunbird, the flowerpecker and the small sunbird (Table 1). The sunbirds (Nectariniidae) with long slender bills (Figure 1), tubular extensile tongues, appear to have more highly developed morphological adaptations for a nectar diet than the flowerpecker (Dicaeidae) which has a semi-tubular tongue

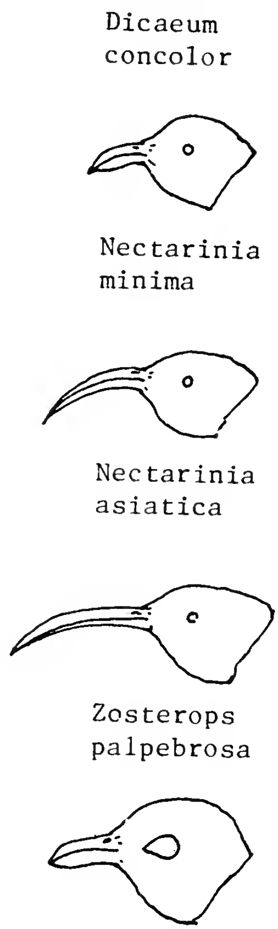


Fig. 1. Bill morphology of the birds.

TABLE 1

MORPHOLOGY AND HABITAT PREFERENCES OF THE BIRDS MAY 1976-OCTOBER 1977

(n = number of birds)

	D. concolor (n=121) $\bar{x} \pm$ S.D.		*N. minima* (n=259) $\bar{x} \pm$ S.D.		*N. asiatica* (n=107) $\bar{x} \pm$ S.D.		*Z. palpebrosa* (=433) $\bar{x} \pm$ S.D.	
Morphology	♂	♀	♂	♀	♂	♀	♂	♀
bill length (mm)	12.4	11.7	15.3	14.7	20.1	18.1	38.5	39
weight (gm)	6.5		5.5	5.25	8.2	8	9.8	
Habitat								
shola	2 ± 0.8		7.7 ± 3		0		8.4 ± 3	
secondary vegetation	1.7 ± 0.3		5.2 ± 2.8		13 ± 0.9		4 ± 0.9	
Stratum	%		%		%		%	
canopy	37		28		5		50	
middle stratum	61		48		52		30	
shrub	2		24		43		20	
Density per hectare	$\bar{x}$		$\bar{x}$		$\bar{x}$		$\bar{x}$	
	1		8 altitudinal migrant		sparse		12	

TABLE 2

FEEDING BEHAVIOUR OF THE BIRDS (n = number of birds)

	Dicaeidae *D. concolor* (n=248)	Nectariniidae *N. minima* (n=932)	Nectariniidae *N. asiatica* (n=114)	Zosteropidae *Z. palpebrosa* (n=490)
% of different food types taken	fruit 47%	—	—	13%
	nectar 28%	37%	62%	10%
	insects 25%	63%	38%	77%

and a short slender bill, and the white-eye (Zosteropidae) which has a semi-tubular brush tipped tongue (Kannan 1966).

Relative abundances and food preferences

The abundances of the birds were different in the different study sites. In the sholas the most abundant species was the white-eye followed by the small sunbird. There were fewer flower-peckers. No purple sunbirds were recorded from the sholas (Table 1). The small sunbirds were most abundant in the secondary vegetation followed by the white-eye, flowerpecker and the purple sunbird. The small sunbird migrated to lower elevations from November to April and was not found in the study sites during that period. The most abundant species in the sholas, the small sunbirds and the white-eyes, were also the most insectivorous (Table 2). The flowerpecker feeds on fruits, with nectar and insects being less important (Table 2). Observations suggest that mistletoe fruits and nectar are an important part of its diet and that it is closely tied in with the flowering and fruiting phases of the mistletoes. A possible explanation for their lower abundance is their dependence on a limited food resource. The small sunbirds and the white-eyes commonly foraged in single or mixed species flocks (*personal observation*), unlike the other two species.

The plants

Distribution and host preferences

H. intermedia and *D. memecylifolia* are found in the sholas on a few tree species. The rest of the mistletoes are found on a wider range of hosts (Table 3).

Flowers

Corolla length in the seven species varied between the longest (*Dendrophthoe falcata*: $\bar{x}$ = 35.5 mm), and the shortest (*Taxillus recurvus:* $\bar{x}$= 10.5 mm) (Table 4). The anthers are introrse and placed at the rim of the corolla tube in all species. Two different types of

TABLE 3

Mistletoe Species	Pollinators	Host preferences
H. intermedia	*N. minima*	Seven native species, and one exotic.
D. memecylifolia	*N. minima*	Four native species.
T. recurvus	*D. concolor* *Z. palpebrosa*	Thirteen native species and eight exotics.
T. cuneatus	*D. concolor* *N. minima* *Z. palpebrosa*	Eighteen native species and nine exotics.
D. neelgherrensis	*D. concolor* *Z. palpebrosa*	Thirty seven native species and fourteen exotics.
D. falcata	rarely visited	Six native species and four exotics.
M. parasiticus	*N. asiatica* *N. minima* *Z. palebrosa*	Thirteen native species and five exotics.

from Davidar 1980.

4

TABLE 4

FLOWER CHARACTERISTICS AND PREFERENCES BY POLLINATORS

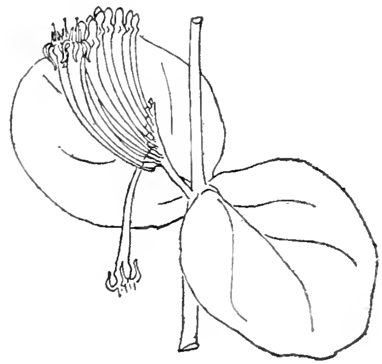
Species of plant	Length of corolla	Colour of corolla	Visits/hour/clump Dc	Nm	Nl	Na	Zp	Remarks
				(n=33 hours)				
H. intermedia	16.5 ± 1.5	pink	0.1	4.4	—	—	—	opens spontaneously
				(n=28)				
D. memecylifolia	25.5 ± 1.5	orange-red	—	3.9	—	—	—	opens spontaneously
				(n=15)				
T. recurvus	10.5 ± 1.5	brown-yellow	1.2	—	—	—	1.1	exploding bud
				(n=21)				
D. neelgherrensis	13.5 ± 2.5	green-yellow	0.7	—	—	—	1.4	exploding bud
				(n=15)				
T. cuneatus	19 ± 3	green-yellow	0.8	1.2	—	—	0.2	exploding bud
				(n=10)				
D. falcata	35.5 ± 2.5	red	0.3	0.5	—	—	0.4	exploding bud
				(n=33)				
M. parasiticus	33 ± 6	scarlet	—	3.1	0.7	0.6	1.3	exploding bud

Dc — *Dicaeum concolor*
Nm — *Nectarinia minima*
Nl — *Nectarinia lotenia*
Na — *Nectarinia asiatica*
Zp — *Zosterops palpebrosa*

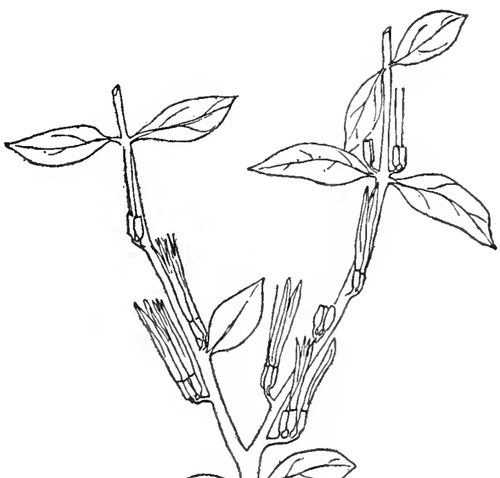
flowers are produced. Certain species have flowers that open naturally, whereas other species have flowers that require external pressure to open (Table 4). These types of flowers have been termed 'exploding' flowers (Kannan 1966) and are characteristic of many Old World mistletoes (Keeble 1901, Docters van Leeuwen 1954, Gill and Wolf 1975b, Davidar 1983). The buds can be divided into a distinct base, neck, and apex (Kannan 1966). Mature buds have either slits at the region of the neck or the apex becomes swollen and turgid (Figure 2a & b). Birds use their bills to open the flowers by either pinching the apex or zipping it open along the slit (Davidar 1983, Kannan 1966). 'Exploding' flowers are characteristic of *T. recurvus*, *T. cuneatus*, *D. neelgherrensis*, *D. falcata* and *M. parasiticus*. Spontaneously opening flowers were produced by *H. intermedia* and *D. memecylifolia* (Table 4).

The flowers are either brightly coloured in some shade of red (*H. intermedia*, *D. memecylifolia*, *D. falcata* and *M. parasiticus*) or

DENDROPHTHOE NEELGHERRENSIS



DENDROPHTHOE FALCATA



DENDROPHTHOE MEMECYLIFOLIA

Fig. 2a. Flowering mistletoes.

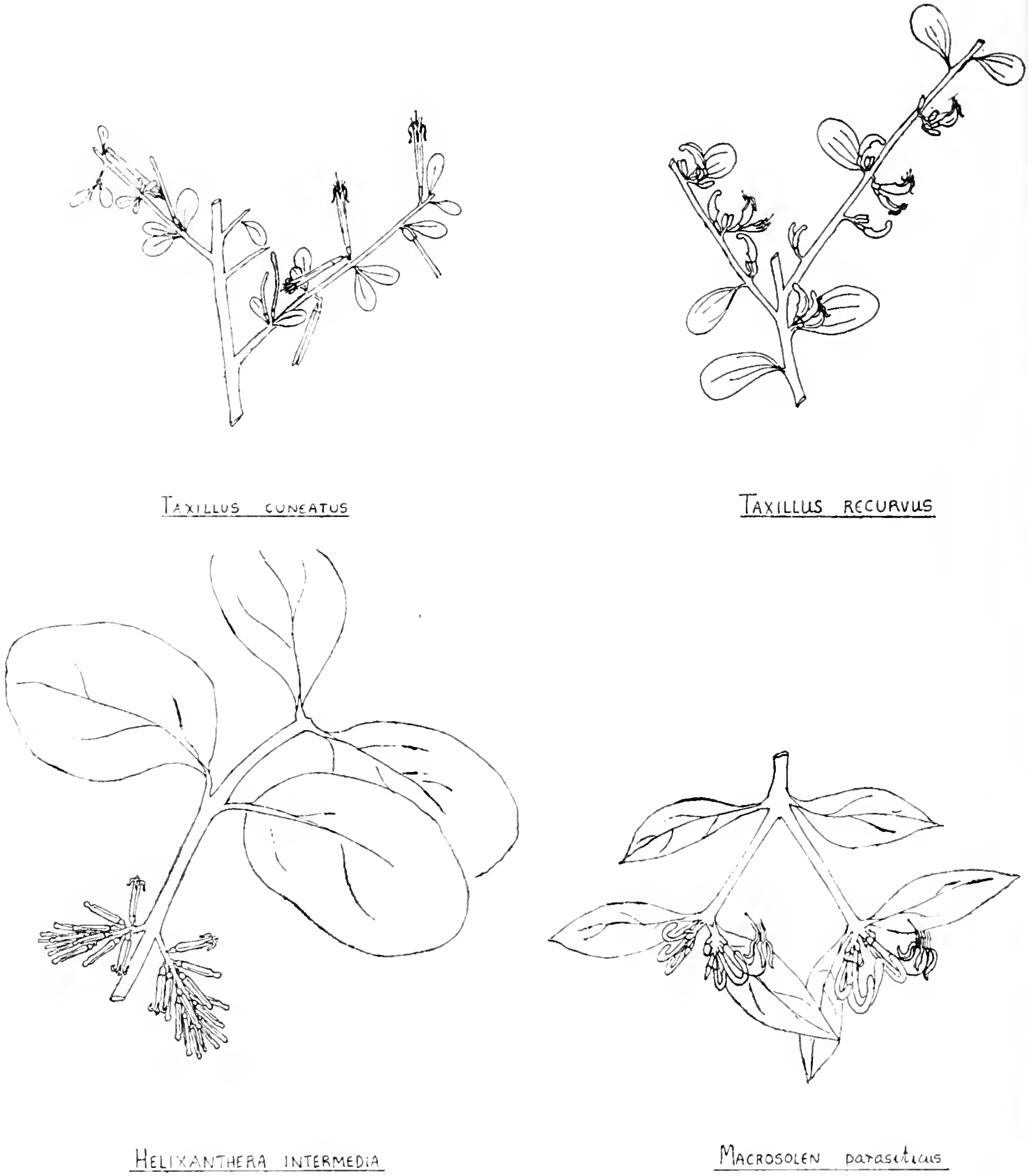

TAXILLUS CUNEATUS
TAXILLUS RECURVUS
HELIXANTHERA INTERMEDIA
MACROSOLEN parasiticus

Fig. 2a. (contd.)

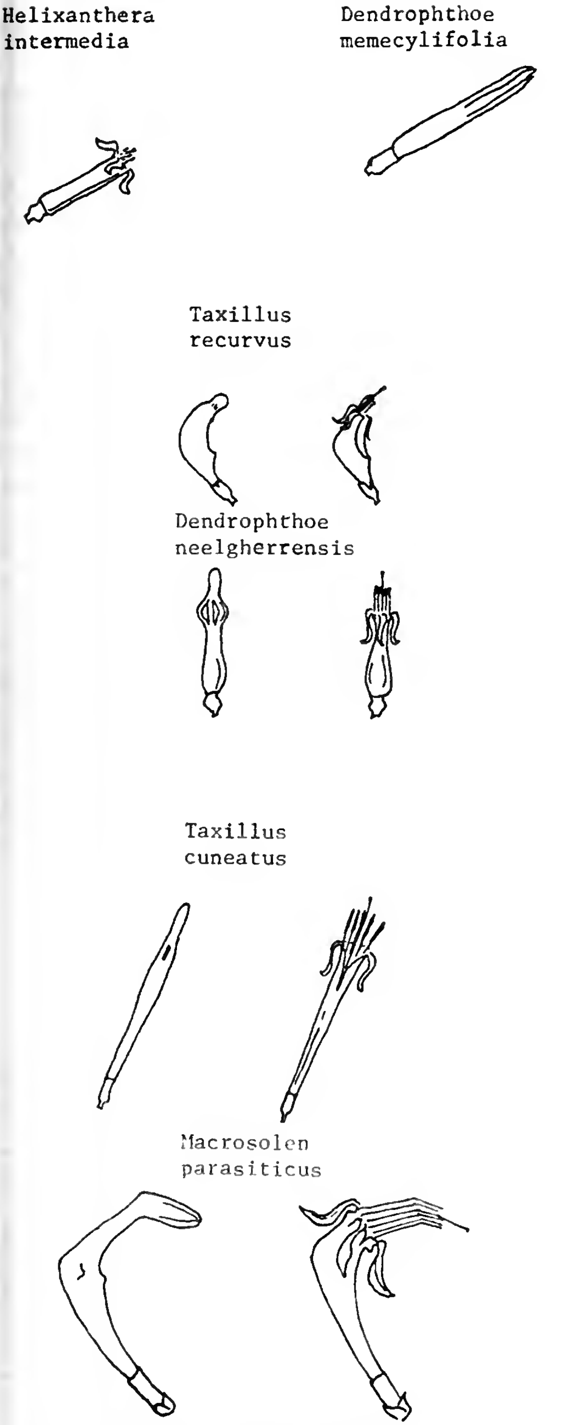


Fig. 2b. Opened flowers and closed buds of the mistletoe species.

fairly cryptic and inconspicuously coloured (*T. recurvus, T. cuneatus* and *D. neelgherrensis*) (Table 4).

Flowering and nectar phenology

The data on flowering phenology gives the length and seasonality of flowering but not the numbers of flowers produced. Three different patterns can be recognised when flowering is considered together with the fruiting phenology (Davidar 1983). In certain species the flowering is temporally separated from the fruiting phase. In others the flowering and fruiting phases run into each other, and in the third pattern, the fruits start ripening at the start of the next flowering season (Davidar 1983).

D. memecylifolia and *H. intermedia* replenish nectar on depletion on the first day of flowering (Table 5). In *T. recurvus* and *D. neelgherrensis*, the nectar is not replenished on depletion (Table 5). There are intermediates

TABLE 5

NECTAR SECRETION PATTERN
(in relative amounts: x roughly = 0.2 μl)

Species	hrs 7.00	9.00	11.00	4.00
*H. intermedia**	xxx	xxx	xxx	
*T. cuneatus**	xxxxxx	xxx	xx	
*T. recurvus**	xxxxxx	—	—	
*D. neelgherrensis**	xxxxxx	—	x	—
D. memecylifolia	xxxxxx	xxx	xxxx	

* from Davidar (1983).

between these two categories like *T. cuneatus, D. falcata* and *M. parasiticus* (Table 5). Generally, species that replenish nectar on depletion produce spontaneously opening brightly coloured flowers, whereas the species in the 'exploding' flowers generally do not replenish nectar on depletion and have fruiting and flowering times that are tied together.

Foraging behaviour of Birds

Flower Preferences

The birds have marked flower preferences (Table 4). The small sunbirds visit the open flowered *H. intermedia* and *D. memecylifolia*. (*H. intermedia* is visited by other sunbird species at lower elevations.) The closed flowered *T. recurvus* and *D. neelgherrensis* are visited by the flowerpecker and the white-eye. The small sunbird, flowerpecker and white-eye visit *T. cuneatus* and *D. falcata*. Both species of sunbirds and the white-eye visit *M. parasiticus*. This is the only mistletoe species in the area that is visited by the purple sunbird. Flowerpeckers preferentially visit closed flowers and do not visit flowers once they are opened, whereas the sunbirds preferentially visit flowers which have opened in all species they pollinate. The white-eyes opportunistically visit both types of flowers (Davidar 1983).

Territoriality

The birds showed different degrees of territoriality and site specificity. Banding data indicate that the small sunbirds were the most site specific. Seventeen small sunbirds were colourbanded and two were subsequently observed defending flowering mistletoes. Individual male birds were also recognised by their distinctive moult patterns. From May until October the male birds moult from breeding to eclipse plumage, and individual moult patterns are distinctive. Twelve different males defended mistletoe flowers over the flowering season of *H. intermedia* and *D. memecylifolia*. One male small sunbird (Z-20072) was recorded defending the same *M. parasiticus* plants for three consecutive years.

The white-eyes appear to be least site specific. The eleven individuals that were colour banded were not sighted subsequently. Flowerpeckers were impossible to capture in mist nets, and so there is no banding record on individuals. However, flowerpeckers seem fairly site specific since individuals or pairs of birds are found in a particular area over a long period of time, and foraging birds can be followed by their loud and distinctive vocalisations. However, flowerpeckers usually forage over a wider area than small sunbirds, and territories seem to be maintained over a longer period of time (*pers. observation*).

The small sunbirds and flowerpeckers actively defend mistletoes against other nectar feeding birds. Advertisement appears to be more important in territorial defence than direct aggression. The territorial birds use call notes constantly, whereas intruding birds do not. However, if the territorial bird found an intruder on a plant, it was chased off. In interspecific conflicts the hierarchic pattern was not constant. Conflicts between bird species were minimised by flower specialisation. The white-eye was chased off from plants by sunbirds and flowerpeckers (Table 6) even though it was larger (Table 1). The purple sunbird did not actively defend mistletoes, though it did

TABLE 6

DOMINANCE INTERACTIONS

Dominant \ Loser	*D. concolor*	*N. minima* male	*N. minima* female	*N. asiatica*	*Z. palpebrosa*
D. concolor	11	6	0	0	0
N. minima male	5	23	12	1	4
N. minima female	0	1	0	0	0
N. asiatica	0	4	0	4	3
Z. palpebrosa	4	4	0	0	22

TABLE 7

BIRDS-FORAGING PATTERN

n = number of observations

Bird species	Time in clump $\bar{x} \pm$ S.D. (m)	Interval between visits (m)	Number of flowers visited	Time/flower (m)
D. concolor	(n=19) 8.7 ± 3.4	(n=13) 14.7 ± 9.9	(n=16) 10.7 ± 9.9	(n=21) 0.17 ± 0.06
N. minima	(n=99) 0.85 ± 0.6	(n=89) 16.4 ± 12	(n=101) 13.3 ± 8.1	(n=51) 0.07 ± 0.02
N. asiatica	(n=11) 1.1 ± 0.8	(n=6) 14.1 ± 23.6	(n=11) 8.6 ± 21	(n=8) 0.16 ± 0.9
Z. palpebrosa	(n=38) 6.7 ± 5.9	(n=27) 31.2 ± 25.8	(n=34) 33 ± 21	(n=18) 0.21 ± 0.16

displace the smaller territorial species from flowers. However, intraspecific conflicts appear to be more common. In the small sunbird, the males seemed dominant over the females. In other species this was not clear (Table 6). It also appeared that the birds were defending a particular site rather than specific plants as bird intruders were always chased off from the territory even when visiting plants that the territorial bird did not feed from (*personal observation*).

Only a few small sunbird males acquired territories. In July 1976 only two out of seven males in Wellington shola defended territories. In May 1976, there were no territorial birds of the six recorded in Sims Park Reserve. Three out of 25 in Sims Park garden were territorial. A large population of small sunbirds, non-territorial males, females and juveniles were found in the shola forests. They frequently visited flowers as intruders in already established territories. They commonly foraged in mixed or single species flocks in the shola. Usually one or two flowerpeckers were found around mistletoes, often foraged and defended mistletoes together. Therefore it is conjectured that these were pairs which defended territories together.

Pollination of the flowers

Movement of pollen

The small sunbirds have similar flower visitation patterns in different areas. The bird stayed on the plant for an average of 34 seconds, and visited a mean of 10 flowers (Table 7). The bird spends a shorter time at *H. intermedia* than at *D. memecylifolia* plants. It usually visits all the flowers on an indivi-

dual *D. memecylifolia*, and about one-third of the flowers on an individual *H. intermedia*. The small sunbird visits approximately one-fourth of the flowers on a *T. cuneatus* plant during peak flowering time (Table 7). The flowerpecker spends a mean of 14 minutes on a *T. recurvus* and visits all the available mature buds. Opened flowers are not revisited (Davidar 1983). While the foraging pattern of the flowerpecker at *T. cuneatus* plants is similar to that at *T. recurvus*, it spends less time at *D. neelgherrensis* and visits approximately half the available flowers. The white-eye visits *T. cuneatus* infrequently and *D. neelgherrensis* approximately four times an hour, oftener than does the flowerpecker. *M. parasiticus* was visited by both species of sunbird and the white-eye. The small sunbird and white-eye foraged as in other species. The purple sunbird was an infrequent visitor (Table 7).

Speculation on the type of pollination that is taking place within plants based on forager visitation patterns indicates that in species with specific territorial pollinators like the small sunbird with *H. intermedia* and *D. memecylifolia*, most of the pollinations will be geitonogamous with pollen being transferred from one flower to its neighbour on the same plant. Outcrossing will occur only if there are a few flowers on a plant and most of the pollen deposited will be from outside sources. In the flowerpecker system there is a chance for greater outcrossing as two species of pollinators are involved, one of which is not a frequent visitor to flowers. However here again data indicate that each flower of *T. recurvus*

TABLE 8

PERCENTAGE FRUIT SET (%)

Species	Self fertilization*	Insects*	Natural conditions**
H. hookeriana	(n=1) 27	(n=2) 57.5	(n=12) 91.5 ± 9.5
H. intermedia	—	(n=1) 53	(n=9) 77.7 ± 16
T. recurvus	(n=4) 0	(n=2) 0	(n=83) 71 ± 36
T. cuneatus	(n=3) 0	(n=3) 0	(n=44) 62 ± 33
D. neelgherrensis	(n=4) 2.2	(n=3) 9	(n=8) 71 ± 8
D. memecylifolia	(n=2) 0	(n=2) 12	(n=3) 74
D. falcata	(n=1) 0	(n=1) 0	(n=7) 32
M. parasiticus	(n=3) 8	(n=2) 12	—

* n indicates the number of experiments.

** n indicates the number of inflorescences.

and *D. neelgherrensis* is visited only once by the flowerpecker and the white-eye (Davidar 1983). These birds rarely visit opened flowers. Thus there is the risk of flowers not getting adequate amounts of pollen.

Another problem that could be encountered in these systems is the clogging of stigmas with pollen from a different species, as both the flowerpecker and the small sunbird territories contain two species of mistletoes flowering at the same time. However in both systems one of the species has a longer corolla tube and correspondingly longer styles and anthers, hence the pollen might not be deposited on the same place on the pollinator. *D. neelgherrensis* has similar-sized flowers as *T. recurvus*, but flowers at a different time of the year.

Seed set and Autogamy

In most species with 'exploding flowers' the buds did not open without avian assistance. The only exception to this was *M. parasiticus*. Without avian intervention the buds dried up unopened (Table 8). In species with exploding buds no fruit set occurred if the flower did not open. However in *D. neelgherrensis* and *M. parasiticus* occasionally a few fruits were set in unopened buds. *H. intermedia* seems to be pollinated partially by insects, as *H. hookeriana*, a related species. The other species appear to be mostly bird pollinated (Table 8).

Autogamy is infrequent in *T. recurvus*, *T. cuneatus*, *D. memecylifolia* and *D. falcata* (Table 8). It is more frequent in *D neelgherrensis* and *M. parasiticus*.

Conclusions

This study indicates that the individual interactions between the bird species and the plant are more important than community level interactions. The aggressive interactions between birds show that intraspecific conflicts are commoner than interspecific conflicts. In conclusion, interspecific competition and the relative foraging behaviours of the different species of birds are not important in organising this system although might have been important over evolutionary time. Rather, it appears as though there has been a long period of coevolution between mistletoes and their particular bird pollinators. The ecology and behaviour of each bird species, specially the small sunbird and the flowerpecker, appears to be closely tied in with the biology of the mistletoes. This appears to be different from hummingbird communities in early successional habitats and in mature forests in the neotropics. In the successional community, Feinsinger (1976) found that short-billed generalist hummingbirds were organised along a resource gradient and interference competition played an important role in determining the patterns. Often one pivotal species modified all other species patterns. Whereas in the mature forests there was a dichotomy between long-billed hummingbirds, the hermits, and short-billed hummingbirds. The non-hermits are limited by corolla length, and behaved more like hummingbirds in early successional communities, whereas the hermits although not limited to flowers by bill length, are non-territorial and active interference competition was rare. The hermits were specialised on flowers with long corolla tubes and seem to be most coevolved with the flowers (Stiles 1975). In East Africa there is a dichotomy between bird visitation to open and closed flowers, with the more dominant and efficient sunbirds taking more closed flowers (Gill and Wolf 1975), and the rest of the species falling into a hierarchy. Both these systems are organised by interspecific competition for nectar.

In the south Indian system, there is no

dichotomy between the long-billed and short-billed birds. The one long-billed species, the purple sunbird was an inconsistent visitor to *Macrosolen parasiticus,* and did not exclude other birds from flowering plants. (It occurred in such few numbers that it might be a recent colonist to the area.) It did not visit any of the flowers with short corolla tubes. It did not even visit *Dendrophthoe falcata* the long corolla. The other two main pollinators — the small sunbird and the white-eye visited different species of mistletoes with short corollas. Although the sunbird preferentially visited open flowers, it did not visit any of the open flowers in the flowerpecker pollinated species like *T. recurvus* and *D. neelgherrensis.* Reciprocally the flowerpecker rarely visited flowers of *H. intermedia* and *D. memecylifolia,* even though these birds often perched on flowering plants of these species (*personal observation*). Thus the dichotomy here is between 'exploding' and 'non-exploding' flowers. The different flower preferences of the birds seem to be maintained by colour and nectar secretion patterns (Stiles 1976). Flowers pollinated by the flowerpecker were inconspicuously coloured and nectar was produced in the mature bud, and often not replenished, whereas flowers visited by the small sunbird were brightly coloured and nectar was secreted continuously in the first day. Patterns intermediate between these were also noted.

This suggests that this system is a result of the different evolutionary and phylogenetic histories of the bird species. The birds have remarkably different behaviours, and these are to an extent characteristic of their respective families. These behaviours have been important in selecting for the characteristics of the plants they pollinate. The sunbirds are more nectarivorous than the other two species. The white-eye is omnivorous and gregarious. The flowerpecker is solitary, more frugivorous and territorial (Ali and Ripley 1974). This implies a certain inflexibility of behavioural repertoires, although individual birds, particularly small sunbirds, do respond flexibly to differential availability of resources in the particular species of plant they visit (Davidar ms.).

The striking pollinator specialisation of the plants might be a result of selection against hybridisation and clogging of stigmas with foreign pollen, and/or because of the specific habitat preferences of the birds and the plants. Related mistletoe species like *T. recurvus* and *T. cuneatus* (and also *T. tomentosus*) were pollinated by the flowerpecker and overlapped in flowering times. *H. intermedia* and *D. memecylifolia,* pollinated by the small sunbird also overlapped in flowering times. Therefore there might be strong selection for pollinator specialisation as one way of avoiding hybridisation.

Data on microhabitat preferences of mistletoes indicates that the birds specialise on species that have particular distributions. The small sunbirds pollinate species that are restricted to specific host species in sholas, whereas flowerpeckers and white-eyes visit species that occupy a wider range of habitats and hosts, and also parasitise introduced plants. Likewise the small sunbirds occur more commonly in sholas, whereas the flowerpeckers range over a variety of habitats. As the flowerpecker disperses the seeds of all mistletoes, the occurrence of its preferred species vis-a-vis nectar, in a wide variety of hosts might not be an artifact of its behaviour patterns. The microsite selection hypothesis is also supported by data on pollinators and host selection by the closely related *Helixanthera* group. *H. obtusata* is the most ornithophilous in this group (Kannan 1966), and occupies the middle levels in the forest where sunbirds are common. *H. intermedia* and *H. wallichiana*

occupy and canopy and subcanopy and are pollinated both by sunbirds and bees (Davidar 1979). *H. hookeriana* which is light tolerant and canopy dwelling is entomophilous. There is a gradation of flower structure from the ornithophilous *H. obtusata,* to the partially insect pollinated *H. intermedia* and *H. obtusata,* to the entirely entomophilous *H. hookeriana* (Kannan 1966, unpublished data).

In conclusion, this bird-flower system in the higher altitudes of southern India suggests close knit evolution between specific bird and plant species. Community level interactions based on interference competition and resource use of the bird species were not important, although they might have been over evolutionary time. However, patterns based on interference competition might be more apparent in a community composed of a single family of nectar feeding birds, as in the neotropics and in E. Africa, where the similarity of morphology and behaviour might lead to greater competition than in a system comprised of different families of birds.

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BREEDING HABITS AND ASSOCIATED PHENOMENA IN SOME INDIAN BATS[1]

PART X — *TAPHOZOUS KACHHENSIS* (DOBSON) — EMBALLONURIDAE

V. M. Sapkal and A. H. Deshmukh[2]

The female genitalia of *Taphozous kachhensis* exhibits a pronounced dominance of the right side since ovulation and pregnancy as a rule occur on the right side of the genitalia. This species experiences an annual sexual cycle. Copulation followed by fertilization and conception occurs in early April. Deliveries take place during the first half of July. The gestation period is 98 days. While the female attains sexual maturity in the year of birth the male does so when it is about 20 months of age. There is an uneven female dominant sex ratio in the adults although the sex ratio at birth appears to be nearly even.

Introduction

Among the Indian emballonurids details of the breeding habits are known about *Taphozous longimanus* (Gopalakrishna 1954, 1955) and *Taphozous melanopogon* (Khaparde 1976, Sapkal and Khamre 1983). Whereas *Taphozous longimanus* is a continuous breeder and the female experiences pregnancies in quick succession, the two uterine cornua alternating in successive pregnancies in carrying the foetus (Gopalakrishna 1954, 1955). *Taphozous melanopogon* has a sharply restricted annual sexual cycle. In this species copulation occurs during the last week of January and conceptions start immediately in the colony. A single embryo is carried as a rule in the right uterine cornu. The left uterine cornu bears the embryo in rare exceptional cases (Sapkal and Khamre 1983). A preliminary study of *Taphozous kachhensis* at Agra revealed that this species differs from the emballonurids mentioned above. It was, therefore, felt that a detailed study of the reproductive habits of *Taphozous kachhensis* may ultimately throw some light on the basic breeding pattern of Indian emballonurids.

Material and Methods

The specimens of *Taphozous kachhensis* (Dobson) were collected from an old fort in Fatehpur Sikri near Agra, Uttar Pradesh. The collections were made during the period between 26th June 1978 and 24th May 1981 so that at least there is one collection representing each calendar month of the year. The specimens were collected in the day time with a butterfly net. After noting the significant characters of the external genital organs in the males and the size and nature of the mammary nipples in the females, the specimens were killed by chloroform and their body weights recorded by a sensitive spring balance. The genital tracts of both males and females were fixed in Bouin's fixative or 10% formalin and were preserved in 70% ethanol. The right testis of each male was

[1] Accepted June 1981.

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TABLE 1

SUMMARY OF THE COLLECTION DIARY

Date	Males				Females						Grand
	Immature		Adult	Total	Immature		Adult			Total	Total
	Attached	Free			Attached	Free	Non-Preg-nant	Pregnant	Lactating		
1	2	3	4	5	6	7	8	9	10	11	12
8-1-1979	—	—	8	8	—	—	14	—	—	14	22
14-1-1980	—	—	5	5	—	1	3	—	—	4	9
26-1-1979	—	—	5	5	—	—	6	—	—	6	11
16-2-1980	—	3	7	10	—	1	11	—	—	12	22
25-2-1980	—	—	6	6	—	1	3	—	—	4	10
27-2-1979	—	1	—	1	—	2	6	—	—	8	9
16-3-1980	—	1	4	5	—	2	12	—	—	14	19
25-3-1979	—	—	2	2	—	—	12	—	—	12	14
13-4-1980	—	3	4	7	—	4	—	23	—	27	34
21-4-1979	—	3	6	9	—	1	—	12	—	13	22
15-5-1980	—	3	6	9	—	—	—	15	—	15	24
24-5-1981	—	—	5	5	—	—	—	5	—	5	10
26-5-1979	—	—	5	5	—	—	—	12	—	12	17
26-6-1978	—	1	5	6	—	—	—	8	—	8	14
4-7-1979	2*	—	2	4	2	—	—	4	5	11	15
23-7-1978	2	—	5	7	2	—	—	—	7	9	16
15-8-1978	—	3	3	6	4	—	—	—	5	9	15
17-9-1978	—	4	4	8	—	3	4	—	—	7	15
13-10-1978	—	2	4	6	—	3	3	—	—	6	12
12-11-1978	—	—	4	4	—	—	4	—	—	4	8
26-11-1978	—	—	—	—	—	—	3	—	—	3	3
24-12-1978	—	—	5	5	—	—	9	—	—	9	14
Total	4	24	95	123	8	18	90	79	17	212	335

* The specimens were twins.

taken out of 70% ethanol, gently rolled on filter paper and weighed in a Mettler balance. This gave accurate relative weights of the testes of different specimens since all the testes were subjected to the same procedure. A detailed field record was maintained on the basis of which tables 1 and 2 were made. Table 1 gives a summary of the collection diary and table 2 gives month-wise collection of the specimens.

TABLE 2

MONTHWISE COLLECTION OF SPECIMENS

Month	Males	Females	Total
January	18	24	42
February	17	24	41
March	7	26	33
April	16	40	56
May	19	32	51
June	6	8	14
July	11	20	31
August	6	9	15
September	8	7	15
October	6	6	12
November	4	7	11
December	5	9	14
Total	123	212	335

OBSERVATIONS

1. *General remarks*

Taphozous kachhensis is one of the largest Indian microchiropteran bats with a prominent deep gular pouch on the ventral side of the lower jaw. The specimens were found at various places hanging from the roof and walls of the fort in isolated groups of 10 to 12. This species is not as active as other bats, and, if disturbed, it flies only for a short distance and settles down. Males and females are found in the same roost throughout the year, and hence no segregation of sexes occurs at any time of the year.

A characteristic feature of this bat is the presence of a large amount of fat in the inguinal region and at the base of the tail. The amount of fat accumulated varies in different seasons of the year. The largest amount of fat was observed during the winter months of November, December and January. The fat undergoes depletion from March and remains in reduced quantity until August. Thus, the weight of the animal varies with the accumulation and depletion of fat. The maximum body weight of the adult male in July was 50 gm. During the winter months the bat is extremely sluggish and does not fly away even when touched. The young ones are not carried by the mothers on their backs as was mentioned by Brosset (1962), but are carried at the breast. During the mating season, that is, during the latter half of March the entire ventral surface of the head and neck in the male was covered with a sticky secretion. During this season a small, but distinct aperture occurs posterior to the gular pouch. It is not clear whether the secretion oozes out of the aperture or not of the gular pouch since the whole area is covered with secretion.

2. *Female genitalia*

The ovary is ellipsoidal in shape and measures 2 mm in length and 0.8 mm in breadth and is enclosed in a complete ovarian bursa. The fallopian tube arises from the postero-median aspect of the bursa, and circles the cranial and lateral margins of the ovary, bends caudally and opens into the cranial end of the respective uterine cornu. The two uterine cornua of the non-parous females are equal in size, while the right cornu is thicker than the left in the parous ones. The two cornua, each

measuring 9 mm in length, meet caudally forming a 'V' shaped structure.

Examination of serial sections of the genitalia reveals that the lumina of the two uterine cornua continue as two distinct cervical canals which extend to about two-thirds of the length of the cervix before joining to form a common canal which opens into the vagina at the tip of the cervix. The vaginal lumen is narrow where the fornices of the vagina surround the cervix and wide caudally. The vagina measures 15 mm in length and opens to the exterior by a transverse opening.

3. *Breeding habits*

An examination of the collection diary and Table 1 reveals that pregnancy, as evidenced by the presence of a bulbous uterine cornu, was noticed from 13th April to 4th July. Out of the 9 adult females collected on 4th July, four carried a fully developed foetus each in the right uterine cornu, and five had just delivered the young, their uteri showing a swollen and flabby appearance typical of post-partum condition. Among the five delivered females, one carried two young ones attached to her mammary nipples, one had just parturated since the placenta had not been expelled and two carried a young one each at the breast. The ninth female although showing a parturated right uterine cornu did not carry a young one at her breast. Evidently, the young one must have been lost accidentally. All the females collected on 23rd July and 15th August were in lactation. These facts indicate that all the deliveries must be taking place during the first three weeks of July. No lactating female was found after 15th August and the young ones collected on the 17th September were all free.

Microscopic examination of the female reproductive tract reveals that the right ovary of females collected on 25th March had vesicular and Graafian follicles. Some of the adult females collected on 13th April had a corpus luteum each in the right ovary, and those collected on 16th April had each a corpus luteum in the right ovary and an implanted blastocyst in the right uterine cornu. From this date onwards the females carried progressively advanced conceptuses. The first batch of females which had delivered their young was collected on 4th July. All females collected on 23rd July were in lactation, and the size of the young at the breast indicated that they may have been delivered about a week earlier. From the above data it is evident that copulation takes place in a sharply defined period in the last week of March, and conception commences immediately. Progressively advanced stages of pregnancy were noticed during the following weeks and delivery occurred in a sharply defined period during the first half of July.

The first batch of young ones delivered on 4th July includes a young one weighing 13 gm which had been just delivered and the mother had not yet expelled the placenta. The fully developed foetus collected on the same date weighed 13 gm. Specimens collected on 15th August included young ones at the breast and they weighed 16 gm. The first batch of free young ones collected on 17th September weighed 23 to 24 gm. Pregnancies were not noticed during any month of the year except the ones mentioned above.

From the above description of the breeding habits of *Taphozous kachhensis*, the annual sexual cycle of the adult females can be categorised as follows :

(1) Period of sexual quiescence — from the middle of September to the last week of March.

(2) Oestrus — copulation and fertilization

during the last week of March and first week of April.

(3) Pregnancy — from April to the middle of July.

(4) Lactation — from July to the middle of September. This conclusion was arrived by taking into consideration the fact that females collected on 17th September were not in lactation, the uterine cornua were normal and the young ones were free.

As a rule a single young one is brought forth during each cycle. There was one exceptional case on 4th July which carried two young ones at the mammary nipples, and both the uterine cornua were swollen and flabby indicating that both the uterine cornua had borne a conceptus each.

From the foregoing it is evident that *Taphozous kachhensis* is a restricted breeder similar to *Taphozous magnus* (Al Rabaake 1968), *Taphozous georgianus* (Kitchner 1973) and *Taphozous melanopogon* (Khaparde 1976, Sapkal and Khamre 1983). This bat differs from the other emballonurids such as *Taphozous longimanus* (Gopalakrishna 1954, 1955) and *Rhynchonycteris naso* (Burt and Stirton 1961) which are continuous breeders.

4. *Number of young and symmetry of the female genitalia*

All the females which showed unquestionable pregnancy, carried their conceptuses in the right uterine cornu. Out of the 13 lactating females collected 12 gave birth to one young each and one to twins. Examination of the ovaries of the lactating females showed a persisting corpus luteum in the right ovary. Thus, as a rule the right ovary releases the ovum and implantation occurs in the right uterine cornu only. The ovaries of the female which gave birth to twins were not examined.

Examination of the ovaries of females collected on 25th March showed the presence of vesicular and Graafian follicles in the right ovary and multilaminar follicles in the left ovary. All the females collected on 13th April showed a corpus luteum in the right ovary indicating that the right ovary had released the ovum. During pregnancy the left non-functional ovary showed a typical anoestrous condition.

Since all the females collected on 13th April had a corpus luteum in the right ovary and an implanted blastocyst in the right uterine cornu and since all females collected after this date showed progressively advanced pregnancies in the right cornu, it is evident that as a rule only the right side of the female genitalia is functioning. Only as a rare exception does the left side also become functional.

5. *Duration of pregnancy*

Histological examination of the genital tract of females collected on 23rd March revealed the presence of spermatozoa in the vagina, uterus and fallopian tubes, but ovulation had not occurred. All the females collected on 13th April had a corpus luteum in the right ovary and an implanted blastocyst in the right uterine cornu. The size and age of the embryo indicate that conception must have started about 15 to 17 days earlier, there being no delayed implantation nor retarded embryonic development, that is, conception must have commenced between 27th and 29th March.

The collection diary and table 1 reveal that pregnancies in progressively advanced stages occur between 13th April and 4th July. A female collected on 4th July had just delivered the young and the newly born young one weighed 13 gm. The latter had closed eyelids, no hair on the body and a stump of the umbilical cord which was still attached to the young one. This taken along with the fact

that the weight of the other young ones attached to the mammary nipples ranged between 13 to 14 gm, and the average weight of the foetuses collected on that date was also 13 gm indicates that the young one must have been delivered a few hours earlier.

From the above data it is evident that the duration of pregnancy in *Taphozous kachhensis* is about 98 days allowing a couple of days on either side.

6. *Growth and maturity*

The collection diary and table 2 give some data on the age of maturity of *Taphozous kachhensis*. The newly born young one weighed 13 gm and the last sucking young ones collected on 15th August weighed 16 to 19 gm. The first few young ones collected on 17th September weighed 23 to 24 gm. The mammary nipples of the females did not ooze out any milk on being pressed and the uterine eornua were normal in appearance on 17th September. At the commeneement of the breeding season in Mareh the immature specimens could not be distinguished from the adult ones on the basis of the body weight and size. However, the size of the testes in the male and the size and nature of the mammary nipples in the females (the size of the mammary nipples of parous females are very conspicuous) and the faet whether the uterine eornu bears an embryo or not are valid eriteria to determine the sexual maturity of this speeies. On the basis of these criteria, during the breeding season, there are many immature males in the colony but not a single immature female as was revealed by the fact that the eolleetions made from the last week of April onwards show that all the females were pregnant. Since this species experiences a single sexual cycle in a year, since immature males with small testes are present in the colony during the breeding season and since all the females become pregnant during the breeding season it is evident that while the males do not attain sexual maturity within the year of birth the females do so. This is further substantiated by the fact that during early pregnancy the virgin females experiencing their first pregnancy can be distinguished from the parous ones by their possessing insignificant mammary nipples.

The above facts reveal that the males require about 20 months to attain sexual maturity while the females reaeh sexual maturity when they are about 9 months of age. The available data do not warrant any conclusion regarding the possible longevity of this species.

7. *Sex ratio*

Collection reeord and Tables 1 and 2 indicate that out of the total of 335 specimens collected of all ages there were 123 (36.7%) males and 212 (63.3%) females. This gives a predominantly female dominant sex ratio for this species. Among the juvenile young ones born in the year, 28 were males and 26 were females, thereby giving a nearly even sex ratio during this period of life. This wide inequality in the number of males to the number of females during adult life is possibly due to preferential mortality of the males during the growth period.

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(* Reference marked in asterisk was not available in the original.)

MATERIAL FOR THE FLORA OF MAHABALESHWAR-6

P. V. Bole and M. R. Almeida

[*Continued from Vol.* 81(2): 379]

Scrophulariaceae

1. Leaves all alternate; corolla tube short.......... *Verbascum*
1. Leaves all or nearly all opposite: corolla tube elongated 2
  2. Climbers .... *Maurandia*
  2. Erect or prostrate herbs 3
    3. Corolla spurred .... *Kickxia*
    3. Corolla not spurred 4
      4. Corolla bilabiate 5
        5. Leaves heterophyllus .... *Limnophila*
        5. Leaves all similar 6
          6. Calyx spathaceous .... *Pedicularis*
          6. Calyx not spathaceous 7
            7. Throat and lip of corolla with palate .... *Lindenbergia*
            7. Throat and lip of corollawithout palate .... *Lindernia*
      4. Corolla regular or sub-equal 8
        8. Parasites 9
          9. Leaves pinnatisect 10
            10. Flowers white; capsules beaked .... *Rhamphicarpa*
            10. Flowers pink or violet; capsules not beaked .... *Sopubia*
          9. Leaves entire 11
            11. Calyx spathaceous .... *Centranthera*
            11. Calyx tubular 12
              12. Corolla tube straight; lobes sub-equal .... *Buchnera*
              12. Corolla tube curved; upper two lobes smaller than the lower ones.......... *Striga*
        8. Non-parasitic plants 13
            13. Corolla with palate .... *Mazus*
            13. Corolla without palate 14
              14. Prostrate or creeping herbs: flowers axillary, solitary; leaves spathulate 15
                15. Perfect stamens 2.......... *Glossostigma*
                15. Perfect stamens 4.......... *Bacopa*
              14. Erect herbs; flowers in axillary and terminal racemes; leaves not spathulate.......... 15
                15. Perfect stamens 4.......... *Scoparia*
                15. Perfect stamens 2.......... *Vernonia*

Bacopa Aublet (nom. cons.)

1. **Bocopa monnieri** (Linn.) Wettst., in Engl. & Prantl., Pflanzenf. 4(3b): 77, 1891; Santapau, in Journ. Bombay nat. Hist. Soc. 49 (1): 30, 1950; Puri & Mahajan, 128.
Lysimachia monnieri Linn., Cent. Pl. 2: 9, 1756.
Herpestis monniera Benth., Scroph. Ind. 30, 1835;

Graham, 144; FBI 4: 272; Cooke, T 651, 1885; Birdwood, 20.

Moniera cuneifolia Mihcaux, Fl. Bor. Amer. 2: 22, 1803; Cooke, T. 2: 285 (2: 356).

Rare, in wet places along watercourses below Venna lake.

FLOWERS: January-May.

LOCAL NAME: Bam.

Buchnera Linn.

1. **Buchnera hispida** Buch.-Ham., ex D. Don, Prodr. Fl. Nepal. 91, 1825; Dalz. & Gibs. 182; Wight, Icon. t. 1413; FBI 4: 298; Birdwood, 20; Cooke, T. 2: 301 (2: 373): Santapau, 49: 42.

A root parasite on grasses. Frequently seen on rocky grounds at Lodwick point.

FLOWERS: November-December.

Centranthera R. Br.

1. **Centranthera indica** (Linn.) Gamble, in Fl. Pres. Madras 5: 683, 1923; G. L. Shah, Fl. Gujrat, 496, 1978.

Rhinacanthus indica Linn., Sp. Pl. 603, 1753.

C. nepalensis D. Don, Prodr. Fl. Nepal. 88, 1825; Santapau, 49: 46.

C. hispida Graham. Cat. Bombay Pl. 145, 1839 (non R. Br. 1810); Dalzell & Gibson, 182; FBI 4: 301; Cooke, T. 2: 308 (2: 381).

This species is reported by Cooke from Wada and Koyna, below Mahabaleshwar. We have not seen it on the plateau.

Glossostigma Arn.

1. **Glossostigma diandrum** (Linn.) O. Kuntze, Rev. Gen. Pl. 461, 1891; Santapau, 186.

G. spathulatum (Hook.) Arn. ex Bentham, in Comp. Bot. Mag. 2: 59, 1836; Dalzell & Gibs. 180; FBI 4: 288; Cooke, T. 2: 299 (2: 371); Santapau, 49: 41.

Microcarpaea spathulata Wight ex Hook., in Bot. Misc. 2: 101, suppl. t. 4, 1831; Graham, 142.

Rare, in moist places near the Venna lake.

FLOWERS: October-December.

Kickxia Dumort

1. **Kickxia incana** (Wall.) Pennell, Acad. Nat. Sci. Phil. Mon. 5: 59, 1943; Santapau, 49: 37.

Linaria incana Wall. Pl. As. Rar. 2: 43-4, 1831; FBI 4: 252.

L. cabulica Benth., in DC. Prodr. 10: 270. 1846.

L. cabulica var. *pubescens* Hook., Fl. Brit. Ind. 4: 251, 1883.

Rare, found on rocky walls at Kate's point.

FLOWERS: December.

Limnophila R. Br. (nom. cons.)

1. Flowers pedicellate .... *L. indica*
1. Flowers sessile .... *L. sessiliflora*

1. **Limnophila indica** (Linn.) Druce, in Rep. Bot. Exch. Club Brit. Isles, 3: 420, 1914; Santapau, 49: 34; Puri & Mahajan, 128.

Hottonia indica Linn., Syst. Nat. ed. 10, 919, 1759.

Cyrilla aquatica Roxb., Pl. Cor. 2: 47, t. 189. 1798.

L. gratioloides R. Br., Prodr. 442, 1810; Dalz. & Gibs. 177; FBI 4: 271; Cooke. T. 651 & 2: 291 (2 : 361).

L. racemosa Benth., Scroph. Ind. 26. 1835; Dalzell & Gibson, 177; FBI 4: 271; Birdwood, 20; Cooke, T. 2: 290 (2 : 362).

Rare, known from a single collection by T. Cooke.

FLOWERS: October.

2. **Limnophila sessiliflora** (Vahl) Benth., Scroph. Ind. 25, 1835; FBI 4: 270; Cooke, T. 2: 290 (2 : 362).

Hottonia sessiliflora Vahl, Symb. Bot. 2: 36, 1791.

L. heterophylla Birdwood, Cat. Fl. Matheran & Mahabaleshwar 20, 1897 (non Benth., 1835); Woodrow, Journ. Bombay nat. Hist. Soc. 12: 174, 1898.

Common and gregarious, along margins of Yenna Lake.

FLOWERS: August-April.

Lindenbergia Lehm.

1. **Lindenbergia muraria** (Roxb. ex D. Don) P. Bruchl., in Journ. Dept. Sci. Calcutta Univ. 2 (Bot.) 27, 1920: Santapau, 330.

Stemodia muraria Roxb., in D. Don. Prodr. 89, 1825.

L. urticifolia Lehm., in Link et Otto, Icon. Pl. Rar. Hort. Berol. t. 48. 1828; Graham, 143; Dalz. & Gibs. 176; Hook., Ic. Pl. t. 875, 1855; FBI 4: 262; Cooke, T. 2: (2: 379).

Rare, weed in cultivated fields and on old walls.

FLOWERS: Throughout the year.

LOCAL NAME: Dhol.

Lindernia All.

1. Leaves parallel nerved 2
   2. Flowers twice as long as calyx; leaves ovate .... *L. parviflora*
   2. Flowers 3-4 times as long as calyx; leaves lanceolate .... *L. hyssopioides*
1. Leaves penninerved 3
   3. Plants diffuse, rooting at lower nodes.. *L. antipoda*
   3. Plants erect, basal branches sometimes diffuse but without roots .... *L. numularifolia*

1. **Lindernia antipoda** (Linn.) Alston, in Trimen, Handb. Fl. Ceylone, 6: 214, 1931; Santapau, 180.

Ruellia antipoda Linn., Sp. Pl. 635, 1753.

R. anagallis Burm. f., Fl. Ind. 135, 1768.

L. anaggalis (Burm. f.) Pennell, in Journ. Arn. Arbor. 20: 81. 1939; Puri & Mahajan, 128.

Bonnaya verbenaefolia Sperng., Syst. 1: 42, 1825; Dalz. & Gibs. 178; Wight, Icon. t. 1412, 1849.

B. veronicicaefolia Spreng. var. *verbenaefolia* Hook.. f.. in Fl. Brit. India. 4 : 295. 1884; Cooke. T. 2: 298 (2 : 370).

B. veronicaefolia (Retz.) Spreng., Syst. 1: 41, 1824; Graham, 143; Dalz. & Gibs. 178; Cooke, T. 2: 298 (2 : 369); Blatter & Hall., in Journ. Bombay nat. Hist. Soc. 25: 418, 1918.

Gratiola veronicaefolia Retz., Obs. Bot. 4: 8, 1786.

G. grandiflora Retz., l. c.

Fairly common herb in moist grounds near Venna lake. A very variable plant.

FLOWERS: August.

2. **Lindernia hyssopioides** (Linn.) Hains, Bot. Bihar & Orissa, 635, 1922; Mukherjee, Journ. Ind. Bot. 24: 132, 1945; Santapau, 49; Puri & Mahajan, 128.

Gratiola hyssopioides Linn., Mant. 174, 1767.

Bonnaya hyssopioides Benth., Scroph. Ind. 34, 1835; Graham, 143.

Illysanthes hyssopioides Benth., in DC. Prodr. 10: 419, 1846; Dalz. & Gibs. 179; FBI 4: 283; Birdwood. 20; Woodrow in Journ. Bombay nat. Hist. Soc. 12, 174, 1899; Cooke, T. 2: 296 (2 : 368)); Blatter & Hall. 25: 419.

This species is included here on the authority of earlier reports only. We have not seen this plant at Mahabaleshwar.

3. **Lindernia parviflora** (Roxb.) Haines, Bot. Bihar & Orissa, 4: 635, 1922; Santapau, 49: 38.

Gratiola parviflora Roxb., Pl. Cor. 3: 3, t. 203, 1819.

Illysanthes parviflora Benth., in DC. Prodr. 10: 419, 1846; FBI 4: 283; Cooke, T. 2: 296 (2: 368); Blatter & Hall. 420.

Vandelia sessiliflora Benth., Scroph. Ind. 37, 1835; (non Benth. 1835).

This species is known only from a single specimen in Sedgwick's herbarium, collected by Nana (No. 7349).

FLOWERS: May.

4. **Lindernia numularifolia** (Don) Wettst. in Engl. & Prantl, Pflanzenfam. 4 (3b): 79, 1891; Gupta, in J. Bombay nat. Hist. Soc. 58: 765, 1961.

Vandelia numularifolia Don. Prodr. Fl. Nepal. 86, 1825.

Vandelia sessiliflora Benth.. Scroph. Ind. 37, 1835; FBI 4: 282.

Vandelia sessiliflora (Benth.) Wetstt., in Pfianzenfam. 4 (3a): 79, 1895; Santapau, 308. 1963.

Bonnaya micrantha Blatter & Hallberg, J. Bombay nat. Hist. Soc. 25: 417. 1918.

Common and locally abundant along Fitzgerald Ghat.

FLOWERS: September.

Maurandia Ort.

1. **Maurandia lophospermum** Bailey, Man. Cult. Pl. 895. 1949.

Lophospermum scandens D. Don, Trans. Linn. Soc. London 15: 353. 1827.

M. scandens (Don) Gray, in Proc. Amer. Acad. 7: 377. 1868 (non Pers. 1807); Cooke, T. 2: 309 (2 : 382); Santapau, 49: 47.

A climbing, cultivated, ornamental plant.

ENGLISH NAME: Plumeseed Maurandia.

Mazus Lour.

1. **Mazus pumilus** (Burm. f.) Van Steenis, in Nou. Guines N. Soc. 9: 31, 1958; G. L. Shah, Fl. Gujrat, 502, 1978.

M. japonica (Thunb.) O. Kuntze, Rev. Gen. Pl. 462. 1891; Santapau, in Journ. Bombay nat. Hist. Soc. 49: 48. 1950.

M. rugosa Lour., Fl. Cochinch. 385. 1790; Dalz. & Gibs. 176; Blatter & Hall., 424.

Lobelia pumila Burm. f., Fl. Ind. 186. t. 60. f. 3. 1768.

Lindernia japonica Thunb., Fl. Jap. 253, 1874.

Common, along grassy slopes in moist and partially shaded places.

FLOWERS: September-November.

Pedicularis Linn.

1. **Pedicularis zeylanica** Benth., Scroph. Ind. 54, 1835; FBI 4: 317; Wight, Icon. t. 1419; Birdwood, 20: Cooke, T. 2: 309 (2 : 381); Puri & Mahajan, 128; Santapau, l.c. 49: 46.

This species is included on the authority of earlier authors. We have not seen it at Mahabaleshwar.

Scoparia Linn.

1. **Scoparia dulcis** Linn., Sp. Pl. 116, 1753; FBI 4: 289; Cooke, T. 2: 310 (2:383); Blatter & Hall. 426; Santapau, 47.

Weed in wastelands and among the grasses in open fields.

FLOWERS: September.

Sopubia Buch.-Ham.

1. **Sopubia delphinifolia** (Roxb.) Don, Gen. Syst. 4: 560, 1837; Graham, 145; Dalz. & Gibs. 182; FBI 4: 302; Cooke, T. 651 & 2: 305 (2: 378); Blatter & Hall., 428; Santapau, 49: 45; Puri & Mahajan, 128.

Gerardia delphinifolia Roxb., Pl. Cor. 1: t. 90. 1795.

Frequent, elegant looking root parasite on grasses, generally found during the second half of the monsoon.

FLOWERS: November.

Striga Lour.

1. Stems purple; leaves reduced to scales .... *S. gesneroides*
1. Stems green; leaves not reduced to scales...... *S. densiflora*

1. **Striga densiflora** (Benth.) Benth., in Hook. Comp. Bot. Mag. 1: 363, 1835; FBI 4: 299; Dalz. & Gibs. 181; Cooke, T. 2: 303 (2: 375); Santapau, 49: 43.

Buchnera densiflora Benth., Scroph. Ind. 41, 1835.

This species has been reported by T. Cooke, from Koyna Valley below Mahabaleshwar. We have not seen any specimen from the area under investigation.

2. **Striga gesneroides** (Willd.) Vatke ex Engl., in Abhadnl. Preuss. Akad. Wissensch. 28: 1894; Santapau, 49: 42; Puri & Mahajan, 128.

Buchnera gesneroides Willd., Sp. Pl. 3: 338. 1801.

B. orobanchoides R. Br. ex Endl. in Fl. 2: 387. t. 2. 1832.

S. orobanchoides (R. Br.) Benth., in Comp. Bot. Mag. 1: 361, t. 19. 1836; Wight, Icon. t. 1414; Dalz. & Gibs. 181; Lee. 625; Birdwood. 20; FBI 4: 299; Cooke. T. 2: 302 (2: 374).

S. coccinea Don ex Graham, Cat. Bombay Pl. 145. 1839 (non Benth., 1836).

A root parasite on *Lepidagathis cuspidata*. The live plant is purplish and it turns black on drying.

FLOWERS: November.

Verbascum Linn.

1. **Verbascum chinense** (Linn.) Santapau, Fl. Purandhar 90, 1958 & Fl. Khandala, ed. 3, 177.

Scrophularia chinensis Linn. Mant. 2: 250, 1771.
V. coromandelianum (Vahl) O.K., Rev. Gen. Pl. 1: 468, 1891; Santapau, 49: 25.
Celsia coromandeliana Vahl, Symb. Bot. 3: 79, 1794; Dalz. & Gibs. 176; Wight, Icon. t. 1406; Birdwood, 20; Cooke, T. 2: 281 (2: 352).

Rare plant in wastelands along roadsides.

FLOWERS: February-June.

Veronica Linn.

1. Leaves lanceolate or oblong-lanceolate upto 8 cm. long .... *V. anagallis-aquatica*
1. Leaves ovate, less than 2.5 cm. long .... *V. javanica*

1. **Veronica anagallis-aquatica** Linn., Sp. Pl. 12, 1753; Pennel, in Acad. nat. Sci. Phil. Mon. 1: 362, 1935.

Veronica anagallis Benth., Scroph. Ind. 44, 1835; FBI 4: 293; Cooke, T. 301 (2: 373); Blatter & Hall., 427; Dutta, in Journ. Bombay nat. Hist. Soc. 57: 594, 1960.

Quite frequent in moist ground near Chinaman's Falls.

FLOWERS: April-May.

2. **Veronica javanica** Blume, Bijdr. 742, 1826; FBI 4: 296; Pennel, l.c. 87; Dutta, l.c. 393.

Weed along the margins of cultivated fields and in waste-lands near Yenna Lake.

FLOWERS: April.

LENTIBULARIACEAE

Utricularia Linn.

1. Leaves orbicular or reniform.........***U. striatula***
1. Leaves not orbicular or reniform............. 2
   2. Pedicels recurved in fruits 3
      3. Spur straight, short, conical .... *U. albo-coerulea*
      3. Spur falcate, linear .... *U. arcuata*
   2. Pedicels not recurved in fruits..............4
      4. Spur curved .... *U. graminifolia*
      4. Spur straight .... *U. uliginosa*

1. **Utricularia albo-coerulea** Dalz., in Kew Journ. Bot. 3: 279, 1851; Dalz. & Gibs. 135; FBI 4: 330; Birdwood, 20; Cooke, T., 651 & 2: 318(2: 391); Puri & Mahajan, 128.

Rare, occasionally found on wet rocks.

FLOWERS: September-November.

LOCAL NAME: Siteche Ashru.

2. **Utricularia arcuata** Wight, Icon. 4: t. 1571, f. 1, 1850; Dalz. & Gibs. 136; Cooke, T., 2: 318 (2: 391-2); Santapau, in J. Bombay nat. Hist. Soc. 49: 218, 1950.

U. ogmosperma Blatter & McCann, in Journ. Ind. Bot. Soc. 3: 123, 1931.

Very common and abundant and at times gregarious on wet rocky ground. Very conspicuous plant due to its bright blue flowers.

FLOWERS: September-October.

LOCAL NAME: Blue Bonnet.

NOTE: *Utricularia ogmosperma* Blatter & McCann, is merged here with *U. arcuata* Wt. In the original description the authors placed it as allied to *U. albomarginata* Dalz., and pointed that it differs from the latter in the following characters:

1. Lateral bracts oblong-ovate below the pedicels.
2. Upper corolla lobe narrowly obovate.
3. Style short, stout.
4. Fruiting pedicels less recurved.
5. Fruits broadly ovoid, almost orbicular, much compressed.
6. Seeds longitudinally and deeply multifurrowed.

All these characters seem to agree closely with the description of *U. arcuata* Wt. We have examined the type of *U. ogmosperma* Blatter & McCann and compared it with Wight's plate. We do not find any difference in these two taxa and therefore consider them as conspecific.

3. **Utricularia graminifolia** Vahl, Enum. 1: 195, No. 3, 1805; Santapau, in Journ. Bombay nat. Hist. Soc. 49: 219, 1950.

U. purpurascens Graham, Cat. Bombay Pl. 165, 1839.
U. coerulea auct. (non Linn., 1753); Cooke, T., Fl. Pres. Bombay 2: 319 (2: 392), 1905; Birdwood, 20; Puri & Mahajan, 128; Santapau, 400, 1962 & 298, 1963.
U. uliginoides Wight, Icon. t. 1573, 1850.
U. pedicellata Wight, Icon. t. 1578, 1850.

U. equiseticaulis Blatter & McCann, Journ. Indian Bot. Soc. 10: 122, 1931.

Very common and abundant herb in water-logged soils and along streams in open places.

FLOWERS: September-June.

4. **Utricularia striatula** Sm., in Res. Cyclop. 37: No. 17, 1819. Cooke, T. 2: 320 (2: 393-4); Santapau, 400, 1962 & 298, 1963.

U. pusilla Graham, Cat. Bombay Pl. 165, 1839 (non Vahl, 1805).

U. orbiculata Wall. ex Oliver, in J. Linn. Soc. 3: 187, 1859; Dalz. & Gibs. 136; FBI 4: 334.

U. glochidiata Wight, Icon. t. 1581, 1850.

Very common on wet rocks and wet tree-trunks in monsoon. An attractive tiny plant with large violet flowers with yellow spot at the base of the lower lip.

FLOWERS: July-December.

5. **Utricularia uliginosa** Vahl, Enum. 1: 203, No. 25, 1804; Santapau, in Journ. Bombay nat. Hist. Soc. 49: 218, 1950.

U. affinis Wight, Icon. t. 1580, f. 1, 1850; FBI 4: 330; Santapau, 400, 1962.

U. decipiens Dalz., in Kew Journ. Bot. 3: 279, 1851.

Common herb on moist rocks among mosses.

FLOWERS: August-November.

GESNERIACEAE

1. Seeds tipped with a long hair; stamens didynamous .... *Aeschynanthus*
1. Seeds not tipped with hair; stamens not didynamous 2
   2. Capsule linear .... *Chirita*
   2. Capsule ellipsoid or oblong .. .. *Rhynchoglossum*

Aeschynanthus Jack. (nom. cons.)

1. **Aeschynanthus perottetii** A. DC., Prodr. 9: 261, 1845; Dalz. & Gibs. 135, Birdwood, 20; Cooke, T. 2: 321 (2: 395).

A. ceylanica Wight. Icon. t. 1347. 1850.

A. grandiflora Graham. Cat. Bombay Pl. 146, 1839 (non Spreng.. 1827).

This species is reported by T. Cooke as occurring in Koyna Valley below Mahabaleshwar. We have not found it on the plateau nor we have seen any specimen from the area under study.

Chirita Buch.-Ham.

1. **Chirita hamosa** R. Br., in Benn. Pl. Jav. Rar. 117, 1840; FBI 4: 360; Cooke, T. 2: 322 (2: 396).

Didymocarpus cristata Dalz., in Kew Journ. Bot. 3: 225, 1851; Dalz. & Gibs. 134.

Rhynchoglossum Blume

1. Stamens 4; calyx winged.........*R. notonianum*
1. Stamens 2; calyx not winged.......*R. obliquum*

1. **Rhynchoglossum notonianum** (Wall.) Burtt, Notes Roy. Bot. Gard. Edinburgh 24: 170, 1962.

Wulfania notoniana Wall.. Tent. Fl. Nepal. 46. 1826.

Klugia notoniana (Wall.) A. DC. in Prodr. 9: 276, 1845; Wight, Ic. t. 1353, 1848; FBI 4: 366. 1884; Lee. 625; Cooke. T. 2: 323 (2: 397); Santapau. 190.

K. scabra Dalz. & Gibs. Bombay Fl. 134. 1861.

Common herb along roadsides on broken walls and on embankments during monsoon. It is more common near Wada and on Pratapgarh Fort.

FLOWERS: September-October.

2. **Rhynchoglossum obliquum** Blume, Bijdr. 741. 1826; var. *parviflorum* C. B. Clarke, in DC. Monogr. Phan. 5: 162, 1883; FBI 4: 367. 1884; Cooke, T. 2: 324 (2: 398); Santapau. 190.

R. obliquum DC.. Prodr. 9: 274. 1845 (p.p.); Wight. Ill. t. 150. f. 7 bis. 1850; T.P. Ramamurthy. in Fl. Hassan Dist. 531. 1976 (non Blume. 1826).

Common herb along road-sides and on old walls. Abundant on walls of Pratapgarh Fort.

FLOWERS: September-October.

BIGNONIACEAE

Heterophragma DC.

1. **Heterophragma quadriloculare** (Roxb.)

K. Schum., in Pfam. 4(3b): 243, 1895; Puri & Mahajan, 128; Santapau, 290, 1963.

Bignonia quadrilocularis Roxb., Pl. Cor. 2: 24, t. 145, 1798; Graham, 125.

H. roxburghii A. DC., Prodr. 9: 210. 1845; Dalz. & Gibs. 160; FBI 4: 381; Lisboa, 219; Cooke, T. 2: 330 (2: 404).

Common tree near Chinaman's water falls.

FLOWERS: February-April.

LOCAL NAME: Varas.

ACANTHACEAE

1. Climbers .... *Thunbergia*
1. Erect or prostrate plants, not climbers 2
   2. Lower lip of corolla large, 3-lobed .... *Blepharis*
   2. Lower lip of corolla not 3-lobed, sub-equal 3
      3. Corolla lobes twisted to the left in buds 4
         4. Ovules more than 2 in each cell; seeds 6-many in each fruit 5
            5. Corolla distinctly 2-lipped .... *Hygrophila*
            5. Corolla sub-equally 5-lobed .... *Hemigraphis*
         4. Ovules 2 in each cell; seeds 4 or less in each fruit 6
            6. Placenta separating elastically from the base of ripe capsule .... *Phaulopsis*
            6. Placenta not separating from the base of ripe capsule 7
               7. Stamens 2 .... *Eranthemum*
               7. Stamens 4 8
                  8. Pollen grains globose, echinulate .... *Thelepaepale*
                  8. Pollen grains ellipsoid 9
                     9. Bands on pollen grains punctate .... *Nilgirianthus*
                     9. Bands on the pollen grains wavy .... *Mackenzia*
                     9. Bands on pollen grains septate 10
                        10. Flowers bracteolate .... *Pleocaulis*
                        10. Flowers ebracteolate .... *Carvia*
      3. Corolla lobes twisted to the right in buds 11
         11. Ovules 3-10 in each cell 12
            12. Cladodes absent .... *Andrographis*
            12. Cladodes present .... *Haplanthus*
         11. Ovules 2 or rarely one in each cell 13
            13. Corolla of 5 subequal lobes 14
               14. Calyx segments 4, unequal .... *Barleria*
               14. Calyx segments 5, subequal .... *Asystasia*
            13. Corolla distinctly 2-lipped 15
               15. Stamens 4 .... *Lepidagathis*
               15. Stamens 2 16
                  16. Placentas separating elastically from the valves from the base upwards 17
                     17. Bracts in unilateral spikes .... *Rungia*
                     17. Bracts clustered in the leaf-axils or laxly cymose .... *Dicliptera*
                  16. Placentas not separating elastically from the valves 18
                     18. Annual herbs .... *Rostellularia*
                     18. Perennial shrubs or undershrubs 19
                        19. Lower anther cells with spur-like appendage at the base .... *Justicia*
                        19. Lower anther cells not spurred at the base 20
                           20. Anther cells apiculate .... *Adhatoda*
                           20. Anther cells muticous .... *Rhinacanthus*

Adhatoda P. Miller

1. **Adhatoda zeylanica** Medic., Hist. & Commentat. Acad. Elect. Sci. Theod.-Palat. 6: 393, 1790; T. P. Ramamurthy, in Fl. Hassan Dist. 540, 1976.

Justicia adhatoda Linn., Sp. Pl. 15, 1753; Graham. 164, Bot. Mag. t. 861, 1805.

A. vasica Nees in Wall. Pl. As. Rar. 3: 103, 1832; FBI 4: 540; Cooke T. 2: 414 (2:494); Santapau. Bot. Mem. Univ. Bombay 2: 92, 1951.

Very rare, in cultivation as a hedge plant. Leaves are reputed for vaso-dilatory properties and used as a remedy in cough and colds.

FLOWERS: August-December.

LOCAL NAME: Adulsa.

Andrographis Wall.

1. **Andrographis echioides** Nees, in Wall. Pl. As. Rar. 3: 117, 1832; Dalz. & Gibs. 198; FBI 4: 505; Cooke, T. 2: 374 (2: 451); Puri & Mahajan, 129.

This species is reported here on the authority of Puri & Mahajan. We have not seen this plant on the plateau.

Asystasia Blume

1. **Asystasia dalzelliana** Santapau, in Kew Bull. 1948: 278, 1948; Santapau, 401, 1962 & 286, 1963.

A. violacea Dalz. ex C. B. Clarke, in Flora Brit. India 4: 495, 1884 (non Dalz.. 1850); Birdwood, 21; Cooke, T. 649, 1885 & 2: 399 (2: 467): Puri & Mahajan, 129.

A. coromandeliana Nees. in Wall. Pl. As. Rar. 3: 89, 1832; Bot. Mag. t. 4248, 1846 (non Wight, 1850); Dalz. & Gibs. 186, 1861.

Rare, but occasionally fairly abundant among the undergrowth in forest areas as well as along road-sides.

FLOWERS: August-October.

LOCAL NAME: Akra.

Barleria Linn.

1. Corolla 7 cm. or more long .... *B. lawii*

1. Corolla less than 6 cm. long...... *B. strigosa* var. *terminalis*

1. **Barleria lawii** T. Anders, in J. Linn. Soc. London 9: 492, 1867; FBI 4: 486; Cooke, T. 2: 383 (2: 460); Santapau, in Mem. 59.

B. longiflora Graham, Cat. Bombay Pl. 161. 1839 (non Linn. f. 1781 nec Roxb. 1832).

B. beddomei T. Anders ex Bedd., Icon. 62. t. 258, 1874.

Occasionally on grassy slopes and along forest paths. Flowers white which make plant very conspicuous during flowering season.

FLOWERS: October-December.

Lee (1885) reports *Barleria grandiflora* Dalz. from Mahabaleshwar. Rev. Fr. Santapau (MEMOIRS, 62) states, "I have not seen this plant in Khandala or anywhere else within the present limits of Bombay State". He has compared it with *B. lawii* and pointed out the differences in size of flowers, apex of corolla-lobes and nervation on dry corollas. It appears these differences are based on the descriptions of the two taxa, as he has not mentioned any specimen belonging to this species. If these two species are treated as distinct then Lee's *B. grandiflora* should be *B. lawii* Dalz., since all plants from Mahabaleshwar have rounded corolla lobes and very conspicuous nerves. The differentiating characters pointed out by Rev. Fr. Santapau are not distinct enough to separate these two species. If they are treated as conspecific *B. grandiflora* Dalz. will have priority as a valid name over *B. lawii* T. Anders. To settle this nomenclatural problem. study of the type specimen of both these species is necessary.

2. **Barleria strigosa** Willd. Sp. Pl. 3: 379, 100; var. **terminalis** (Nees) Clarke, in Flora Brit. India 4: 490, 1884; Birdwood, 21; Cooke. T. 2: 384 (2: 462); Santapau, in Memoirs 61.

B. terminalis Nees, in DC. Prodr. 11: 225, 1847; Dalz. & Gibs. 188; Cooke. T. 649. 1885; Lee. 625.

B. caerulea Graham, Cat. Bombay Pl 161, 1839; (non Roxb., 1832).

A common bushy shrub on grassy hill-slopes and along forest paths, Fitzgerald ghat and Hart point.

FLOWERS: November-December.

LOCAL NAME: Koranti, Nili Itari.

Blepharis Juss.

1. **Blepharis asperrima** Nees, in DC. Prodr. 11: 267, 1847; Dalz. & Gibs. 192; Wight, Icon. t. 1534, 1850, FBI 4: 478; Lee, 625; Cooke, T. 651 & 2: 349 (2: 424); Lisboa, 219; Birdwood, 21; Puri & Mahajan, 129; Santapau, in Memoir 14.

Common and abundant prostrate or sometimes ascending herb in partially shaded forest margins.

FLOWERS: October-January.

LOCAL NAME: Dikna.

Carvia Bremek.

1. **Carvia callosa** (Wall.) Bremek., in Mat. Mon. 187, 1944; Santapau, in Memoirs, 46; Puri & Mahajan, 128; Santapau, 399; 1962 & 286, 1963.

Strobilanthes callosus Wall., Pl. As. Rar. 3: 85, 1832; Dalz. & Gibs. 188; Cooke, T. 649 & 2: 368 (2: 444); Lisboa 219; Markham, 385; Birdwood, 21.

S. grahamianus Wight, Icon. t. 1520, 1850; Dalz. & Gibs. 188; Lee, 625.

S. ciliata Graham, Cat. Bombay Pl. 162, 1839 (non Nees, 1832).

One of the commonest and most abundant plants, often gregarious on hill slopes. During the explorations of Mahabaleshwar, the senior author has twice observed the general flowering of this species: once in September 1954 and again in between August and November 1959. It appears that the flowering cycle of this species at Mahabaleshwar is rather irregular. For full details of this species see H. Santapau (*J. Bombay nat Hist. Soc.* 44: 605, 1944).

LOCAL NAME: Carvi, Karau.

Dicliptera Juss.

1. **Dicliptera zeylanica** Nees, DC. Prodr. 11: 474, 1847; FBI 4: 552; Cooke, T. 2: 403 (2: 482); Santapau, in Memoirs 79; Birdwood, 21; Puri & Mahajan, 128.

D. bivalvis Nees, l.c. 475, 1847; Wight, Icon t. 1551, 1850; Dalz. & Gibs. 196 (non Juss., 1807); Lee 625; Cooke, T. 651, 1885.

Justicia bivalvis Graham, Cat. Bombay Pl. 164, 1839 (non Linn. 1760).

Fairly common on shady hill-slopes and among the forest undergrowth.

FLOWERS: June-July.

Eranthemum Linn.

1. **Eranthemum roseum** (Vahl) R. Br., Prodr. 477, 1810; Dalz. & Gibs. 195; Santapau, in Memoirs, 34.

Justicia rosea Vahl, Enum. 1: 165, 1804.

Daedalacanthus roseus T. Anders, in Journ. Linn. Soc. London. 9: 487, 1867; FBI 4: 419; Birdwood, 21; Cooke, T. 2: 363 (2: 439).

A common undershrub in shady places among the undergrowth in forest areas.

FLOWERS: October-January.

Haplanthus Nees

1. **Haplanthus verticillatus** (Roxb.) Nees, in DC. Prodr. 11 : 513, 1847; Dalz. & Gibs. 197; FBI 4: 506; Birdwood, 21; Cooke, T. 651 & 2: 375 (2: 452); Puri & Mahajan, 129 (***H. verticillaris***).

Justicia verticillata Roxb., Fl. Ind. 1: 135, 1832; Graham, 165.

Fairly common and abundant herb along road-sides and among the forest undergrowth in shady places. It is a very conspicuous plant due to its cladodes.

FLOWERS: January-June.

LOCAL NAME: Kala Kiraita, Kala Ankra.

Hemigraphis Nees

1. **Hemigraphis latebrosa** (Heyne ex Roth.) Nees in DC. Prodr. 11: 723, 1847; FBI 4: 423; Wight, Icon. t. 1504, 1850; Birdwood, 21; Cooke, T. 2: 358 (2: 434).

Ruellia latebrosa Heyne ex Roth., Nov. Pl. Sp. 307, 1821.

R. elegans Sm., Bot. Mag. t. 3389, 1835; Graham, 162; Dalz. & Gibs. 186.

Hemigraphis latebrosa Nees, var. *heyneana* Bremek. in Mat. Monogr. Strob. 139, 1944; Santapau, Memoirs, 26 & Fl. Khandala ed. 3, 196, 1967.

Common in undergrowth in forest areas and along road-sides in shade.

FLOWERS: January-February.

Following Bremekamp (l.c.) Rev. Fr. H. Santapau accepts the name as *Hemigraphis latebrosa* Nees var. *heyneana* Bremekamp for this taxon. Later authors follow this nomenclature in all recent works. Bremekamp, however, distinguished his variety *heyneana* from other varieties of *Hemigraphis latebrosa* based on Heyne's specimen, which is actually the type of *Ruellia latebrosa* Heyne ex Roth. According to Article 53 of International Code of Botanical Nomenclature, when a species is divided into two or more varieties the typical variety should be called by its specific epithet only. Therefore Bremekamp's varietal name is superfluous and must be rejected. The correct name for this taxon should be *Hemigraphis latebrosa* (Heyne ex Roth.) Nees var. *latebrosa.*

Hygrophila R. Br.

1. Plants armed with whorl of spines.. *H. auriculata*
1. Plants unarmed .... *H. serpyllum*

1. **Hygrophila auriculata** (K. Schum.) Heyne, Kew Bull. 16: 172, 1962; Santapau, Fl. Khandala, ed. 3, 194.

Barleria auriculata K. Schumach., in Schumach. & Tonn. Beskr. Guin. Pl. 285, 1827.

B. longifolia Linn., Amoen. Acad. 4: 320, 1759 (non *H. longifolia* Nees, 1847).

Asteracantha longifolia Nees in Wall. Pl. As. Rar. 3: 90, 1832; Wight, Icon. t. 499, 1841; Dalz. & Gibs. 189; Cooke. T. 2: 352 (2: 428); Santapau, in Mem. 17; Puri & Mahajan, 129.

H. spinosa T. Anders. in Twaites, Enum. 225, 1860; FBI 4: 408.

Common along watercourses and in stagnant water pools.

FLOWERS: October-February.

LOCAL NAME: Talim Khana, Kolsunda.

2. **Hygrophila serpyllum** (Nees) T. Anders. in J. Linn. Soc. London, 9: 456, 1867; FBI 4: 406; Cooke, T. 651 & 2: 354 (2: 429); Birdwood, 21; Santapau, in Memoirs 19; Puri & Mahajan, 129.

Physichilus serpyllum Nees, in Hook. Comp. Bot. Mag. 2: 311, 1837; Dalz. & Gibs. 184; Wight. Icon. t. 1493, 1849.

Very common and abundant herb, found in large dense patches in wet grounds and along watercourses.

FLOWERS: October-April.

LOCAL NAME: Ran Tewan.

Justicia Linn.

1. Shrubs; Flowers more than 25 cm. long....................................... *J. santapaui*
1. Perennial herbs or undershrubs; flowers less than 15 mm. long 2
   2. Bracts foliaceous 3
      3. Procumbent herbs .... *J. trinervia*
      3. Erect undershrubs .... *J. betonica*
   2. Bracts linear, very small........ *J. gendarussa*

1. **Justicia betonica** Linn. Sp. Pl. 15, 1753; FBI 4: 525; Talbot 2: 338; Santapau, Memoirs 85, & Fl. Khandala, ed. 3, 208; Puri & Mahajan, 129.

J. ramosissima Roxb. Fl. Ind. 1: 129, 1832; Graham. 165.

Adhatoda betonica Nees, in Wall. Pl. As. Rar. 3: 103, 1832.

A. ramosissima Nees, l.c. 103, 1832; Dalz. & Gibs. 193.

J. betonica var. *ramosissima* Clarke, Fl. Brit. Ind. 4: 525, 1885; Cooke, T. 2: 407 (2: 486).

Common straggling or at times erect undershrub in open forests and along road-sides. Conspicuous because of its scarious white bracts with green nerves.

FLOWERS: November-December.

2. **Justicia gendarussa** Burm., Fl. Ind. 10, 1768; FBI 4: 532; Graham, 164; Dalz. & Gibs. suppl. 71; Cooke, T. 2: 412 (2: 492); Santapau, Memoirs 91.

Cultivated occasionally as a border plant in gardens.

FLOWERS: January-May.

3. **Justicia santapaui** Bennett, in J. Bombay nat. Hist. Soc. 67: 358, 1970.

J. montana (Nees) Wall. ex T. Anders. in Journ. Linn. Soc. 9: 509, 1867 (non Roxb., 1805); FBI 4: 525; Cooke, T. 2: 406 (2: 485); Santapau, Memoirs, 85.

Hemichoriste montana Nees, in Wall. Pl. As. Rar. 3: 102, 1832; Dalz. & Gibs. 194; Wight, Icon. t. 1538, 1850.

A rare species at Mahabaleshwar. Only known from a single collection by Dalzell.

FLOWERS: February.

4. **Justicia trinervia** Vahl, Enum. 1: 156, 1804; FBI 4: 256; Cooke, T. 2: 408 (2: 487); Santapau, Memoirs, 86; Puri & Mahajan, 129.

Adhatoda trinervia Nees, in Wall. Pl. As. Rar. 3: 103, 1832; Dalz. & Gibs. 194.

Rare prostrate herb on rocky grounds in open fields.

FLOWERS: October-January.

LOCAL NAME: Suta, Pandhra Suta.

Lepidagathis Willd.

1. Seeds 2 in each capsule............*L. prostrata*
1. Seeds 4 in each capsule............*L. cuspidata*

1. **Lepidagathis cuspidata** Nees, in Wall. Pl. As. Rar. 3: 97, 1832; FBI 4: 519; Cooke, T. 2: 396 (2: 474); Santapau, in Memoirs, 73; Puri & Mahajan, 129.

Fairly common erect or straggling deciduous undershrub on rocky grounds. Bracts, bracteoles and leaf-apices are with sharp spines. Very often a parasitic plant *Striga gesnerioides* is found growing on roots on this species.

FLOWERS: January-March.

2. **Lepidagathis prostrata** Dalz., in Kew Journ. Bot. 2: 138, 1850; Dalz. & Gibs. 190; FBI 4: 518; Cooke, T. 2: 395 (2: 473); Lisboa, 219.

This species is included here on the authority of Lisboa.

Nilgirianthus Bremekamp

1. **Nilgirianthus reticulatus** (Stapf) Bremek., in Mat. Mon. Strob. 173, 1944; Santapau, in Mem. 41 & Fl. Khandala, ed 3, 197.

Strobilanthus reticulatus Stapf in Kew Bull. 1894: 347, 1894; Cooke, T. 2: 366 (2: 442); Puri & Mahajan, 129.

Very common and abundant, often gregarious in large clumps, on open grounds and on grassy slopes. Very showy plant when in bloom.

FLOWERS: November-December.

Rhinacanthus Nees

1. **Rhinacanthus nasuta** (Linn.) Kurz. in Journ. Asiat. Soc. Bengal 39: 79, 1870; Santapau, Memoirs, 92 & Fl. Khandala, ed. 3, 210.

Justicia nasuta Linn. Sp. Pl. 16, 1753; Graham, 164.

R. communis Nees, in Wall. Pl. As. Rar. 3: 109, 1832; FBI 4: 541; Wight, Icon. t. 464, 1843; Dalz. & Gibs. 194; Cooke, T. 2: 415 (2: 494).

A rare species along the ghats in partially shaded places but conspicuous due to its leafless condition when it has numerous white flowers.

FLOWERS: November-April.

LOCAL NAME: Gajakarni.

Rostellularia Reichenb.

1. Bracts linear; white hairs on bracts not jointed.

. . . . *R. procumbens*
1. Bracts elliptic-ovate; white hairs on bracts jointed . . . . *R. mollisima*

1. **Rostellularia procumbens** (Linn.) Nees, in DC. Prodr. 11: 351, 1841; Santapau, Fl. Khandala, ed. 3, 209.

Justicia procumbens Linn., Sp. Pl. 15, 1753; FBI 4: 539; Cooke, T. 2: 412 (2: 491); Santapau. in Memoirs, 90. Puri & Mahajan, 129.

Rostellaria procumbens Nees. in Wall. Pl. As. Rar. 3: 101, 1832 (non Gaertn., 1791); Dalz. & Gibs. 193.

A rare herb in waste-lands and along roadsides.

FLOWERS: July-October.

LOCAL NAME: Karambal.

2. **Rostellularia mollisima** (Nees ex Wall.) Nees ex DC. Prodr. 11: 373, 1847.

Justicia simplex D. Don, Prodr. Fl. Nepal. 118, 1825; FBI 4: 539; Cooke, T. 2: 441 (2: 490); Puri & Mahajan, 129. (non *Rostallularia simplex* Wt., 1850).

Rostellaria mollisima Nees. in Wall. Pl. As. Rar. 3: 101, 1832.

Common annual herb among grasses on rocky ground. Very often the plants are seen growing on old broken walls.

FLOWERS: August-November.

Rungia Nees

1. Bracts dimorphic . . . . *R. pectinata*
1. Bracts all similar . . . . *R. repens*

1. **Rungia pectinata** (Linn.) Nees, in DC. Prodr. 11: 469, 1847; Wight, Icon. t. 1547, 1850; Santapau, in Memoirs. 77; Puri & Mahajan, 129.

Justicia pectinata Linn., Amoem. Acad. 4: 299. 1759; Graham, 165.

R. parviflora Dalz. & Gibs., Bombay Fl. 195, 1861 (non Nees, 1832); Birdwood, 21; Lisboa, 219.

R. parviflora var. *pectinata* Clarke, in Flora Brit. Ind. 4: 550, 1885; Cooke, T. 2: 400 (2: 478).

Common herb along roadsides and in open grounds.

FLOWERS: October-March.

2. **Rungia repens** (Linn.) Nees, in Wall. Pl. As. Rar. 3: 110, 1832; Dalz. & Gibs. 196; Wight, Icon. t. 465; FBI 4: 549; Birdwood, 21; Cooke, T. 2: 402 (2: 480); Lisboa, 219.

Justicia repens Linn., Sp. Pl. 15, 1753; Graham, 165.

This species is reported here on the authority of Lisboa. We have not seen it at Mahabaleshwar and there is no specimen in any herbaria from the area under study.

Phaulopsis Willd. emend. Spr. (nom. cons.)

Graham (1839) and Puri & Mahajan (p. 129) have reported *Phaulopsis dorsiflora* (Retz.) Santapau from Mahabaleshwar. We have not seen this species at Mahabaleshwar or in any of the herbaria consulted. The report of its occurrence at Mahabaleshwar seems to be persisting due to the mention of *Ruellia imbricata* in Graham's CATALOGUE for which he gives a vernacular name 'Waiti'. T. Cooke, in FLORA OF PRESIDENCY OF BOMBAY cites *Ruellia imbricata* Vahl as synonym of present taxon, whereas Rev. Fr. Santapau, in MEMOIRS (1951) as well as in FL. KHANDALA ed. 3 (1967) cites *Ruellia imbricata* Forsk. as the synonym of this taxon. What aggrevates the nomenclatural confusion further is that *Ruellia imbricata* of Graham has been cited in synonymy of the present species as well as in the synonymy of *Thelepaepale ixiocephalus* (Benth.) Bremek., in FL. KHANDALA ed. 3, by Rev. Fr. Santapau, probably because it is called 'Waiti' in Khandala.

Thelepaepale Bremek.

Thelepaepale ixiocephalus (Benth.) Bremek., in Mat. Mon. Strob. 188, 1944; Santapau, 399, 1962 & Fl. Khand. ed. 3, 198.

Strobilanthes ixiocephalus Benth., in Flora 32: 557, 1849; Birdwood, 21; Cooke, T. 2: 372 (2: 448); Puri & Mahajan. 129.

S. neesiana Wight, Icon. t. 1523, 1850; Dalz. & Gibs. 188; Lisboa, 219.

S. glutinosa Graham, Cat. Bombay Pl. 162, 1839 (non Nees 1832).

Ruellia imbricata Graham, Cat. Bombay Pl. 162, 1839 (non Roxb. 1832).

Common shrub along forest borders.

FLOWERS: October-June.

LOCAL NAME: Warti.

Thunbergia Retz. (nom. cons.)

1. Flowers axillary, solitary or in pairs (rarely up to 6) white .... *T. laevis*
1. Flowers in racemes, coloured 2
   2. Flowers yellow .... *T. mysorensis*
   2. Flowers blue or purple or lilac.. *T. grandiflora*

1. **Thunbergia laevis** Nees, in Wall. Pl. As. Rar. 3: 77, 1832; Santapau & Panthaki, in Journ. Bombay nat. Hist. Soc. 53: 500, 1956.

T. fragrans auct. (non Roxb., 1795); Graham, Cat. Bombay Pl. 163, 1839, Dalz. & Gibs. 183; Cooke T. 2: 342 (2: 417); Santapau, Memoirs 8. (Omnes pro parte tantum).

T. fragrans var. *laevis* Clarke, in Fl. Brit. India, 4: 391. 1884.

Common climber among bushes.

FLOWERS: July-December.

2. **Thunbergia grandiflora** (Roxb. ex Rottl.) Roxb., Fl. Ind. 3: 34, 1832; Graham, 163; Wight, Icon. t. 872, 1845; Dalz. & Gibs. Suppl. 70; FBI 4: 392; Santapau, in Memoirs, 9.

Flemingia grandiflora Roxb. ex Rottl. in Ges. Natur. f. Neue Schr. 4: 202, 1803.

A cultivated climber occasionally grown in gardens. Flowers purplish-blue, showy.

FLOWERS: September-April.

3. **Thunbergia mysorensis** T. Anders. in Journ. Linn. Soc. London, 9: 448, 1867; FBI 4: 393; Birdwood, 20; Cooke, T. 2: 342 (2: 417).

Hexacentris mysorensis Wight, Icon. t. 871, 1845; Dalz. & Gibs. 183; Bot. Mag. t. 4786, 1854.

Rarely cultivated in gardens.

FLOWERS: December-January.

VERBENACEAE

1. Inflorescence with the lowest flowers opening first (centripetal) 2
   2. Fruit a one-seeded pyrene 3
      3. Flowers sessile, in spikes .... *Lantana*
      3. Flowers pedicellate, in racemes..*Duranta*
   2. Fruits 2-seeded pyrenes .... *Priva*
1. Inflorescence cymose, centrifugal 4
   4. Leaves digitate .... *Vitex*
   4. Leaves not digitate, simple 5
      5. Corolla regular; stamens equal .... *Callicarpa*
      5. Corolla irregular, 2-lipped; stamens didynamous .... *Clerodendrum*

Callicarpa Linn.

1. **Callicarpa tomentosa** (Linn.) Murr., in Linn. Syst. Veg. ed. 13, 130, 1774; Meeuse, in Blumea 5: 71, 1942; Santapau, 399, 1962 & 310, 1963; Puri & Mahajan, 130.

Tomex tomentosa Linn. Sp. Pl. 172, 1753.

C. lanata Linn. Mant. 2: 331, 1771; Graham, 156; FBI 4: 567; Birdwood, 22; Cooke, T. 2: 423 (2: 502); Talbot, 2: 345.

C. cana Dalz. & Gibs., Bombay Fl. 200, 1861 (non Linn. 1753); Markham, 385; Cooke, T. 649; Lisboa, 220.

Common shrub, rarely attaining height of a small tree, found generally on way to Chinaman's Falls and Lodwick point. Very beautiful tree during flowering season when it produces purple flowers and the leaves are coated with white woody tomentum, which is easily detachable in the form of felt.

FLOWERS: December-April.

LOCAL NAME: Yesur.

Clerodendrum Linn.

1. **Clerodendrum serratum** (Linn.) Moon, Cat. 46, No. 386, 1824; Graham, 157; Dalz. & Gibs. 200; Wight, Icon. t. 1472, 1849; FBI 4: 492; Cooke, T. 651 & 2: 432 (2: 512); Birdwood, 22; Talbot 2: 359; Puri & Mahajan, 130.

Volkameria serrata Linn. Mant. Pl. 90, 1767.

Shrub occasionally, found among the undergrowth of forests mostly in sunny situations. Light purple flowers and sharply serrate leaves render identification of this species easy.

FLOWERS: July-September.

LOCAL NAME: Bharang.

Duranta Linn.

1. **Duranta repens** Linn., Sp. Pl. 637, 1753; Bailey, Man. Cult. Pl. 843, 1949; Santapau, Fl. Khandala, ed. 3, 215.

Duranta plumieri Jacq., Select. Stirp. Amer. Hist. 186. t. 176, f. 76. 1763; Dalz & Gibs. suppl. 70; FBI 4: 560—(in note): Cooke. T. 2: 437 (2: 518).

Common hedge plant all over Mahabaleshwar.

FLOWERS & FRUITS: May-June.

LOCAL NAME: Duranti.

Lantana Linn.

1. Unarmed trailing shrubs ...... *L. montevidensis*
1. Armed. erect or straggling shrubs .... *L. camara* var. *aculeata*

1. **Lantana camara** Linn. var. **aculeata** (Linn.) Moldenke, in Torreya 34: 9, 1934; Bailey, Man. Hot. 842. 1949; Santapau, Fl. Khadala, ed. 3, 211.

Lantana aculeata Linn. Sp. Pl. 627, 1753; Graham. 156, Dalz. & Gibs. suppl. 68; Lisboa, 220; Talbot 2: 344; Bor, Man. Ind. For. Bot. 300, 1953.

L. camara auct. (non Linn., 1753): C. B. Clarke. in Flora Brit. Ind. 4: 562, 1888 (in note); Birdwood. 22; Cooke. T. 2: 419 (2: 498); Puri & Mahajan. 130.

The plant was an introduction from Tropical America as an ornamental garden plant. But now it has thoroughly established itself all over the country, and in many parts of Maharashtra it is a serious pest, generally forming very dense and often impenetrable thickets. Scratches caused by spines on the stems often cause septic wounds and ulceration of skin. At Mahabaleshwar, so far, the plant does not appear to be so wide-spread as to be a nuisance.

FLOWERS: Throughout the year.

LOCAL NAMES: Ghaneri, Tantani.

2. **Lantana montevidensis** Briq. in Ann. Conserv. Jard. Bot. Geneve 7-8: 301, 1898; Bailey, 842.

Lippia montevidensis Spr., Syst. Veg. 2: 751, 1825.

A trailing shrub, cultivated as an ornamental at Bhilar Estate.

FLOWERS: November.

Priva Adans.

1. **Priva leptostachya** (Linn.) Juss., in Ann. Mus. Paris 7: 70, 1806; Dalz. & Gibs. 198; FBI 4: 565; Birdwood, 22; Cooke, T. 2: 422. (2: 502).

Streptium asperum Roxb., Cor. Pl. 2: 25, t. 146. 1798; Graham. 154. (non *Priva aspera* H.B.K., 1817).

Phryma leptostachya Linn. Sp. Pl. 601, 1753.

This species is reported by Birdwood from Kate's point and Luisa point. We have not seen any authentic specimen from Mahabaleshwar.

Vitex Linn. f.

1. A large deciduous tree.......... *V. leucoxylon*
1. An evergreen shrub 2
   2. Margins entire .... *V. negundo* var. *negundo*
   2. Margins serrate .... *V. negundo* var. *incisa*

1. **Vitex leucoxylon** Linn. f., suppl. 293. 1781; Graham. 156; Dalz. & Gibs. 201; FBI 4: 587; Cooke, T. 2: 430 (2: 510).

Wallrothia leucoxylon Roth., Nov. Pl. Sp. 319. 1821; Wight. Icon. t. 1467, 1850.

This species has been reported by T. Cooke from Koyna Valley below Mahabaleshwar. We have not seen it on the plateau, nor have we seen any authentic specimen from the area under study.

2. **Vitex negundo** Linn. Sp. Pl. 638, 1753; Wight, Icon. t. 519, 1842; FBI 4 : 583; Cooke, T. 649 & 2 : 428 (2 : 508); Lisboa 220; Birdwood, 22; Talbot 2 : 353; Puri & Mahajan, 130.

V. bicolor Willd., Enum. Hort. Berol. 600. 1810; Dalz. & Gibs. 201.

V. trifolia Graham, Cat. Bombay Pl. 155, 1839 (non Linn., 1753).

A common evergreen shrub or a small tree, cultivated as a hedge plant. It is also found wild near villages. This species is locally reputed as a cure for arthritis.

FLOWERS: Throughout the year.

LOCAL NAMES: Nirgudi, Lingar.

3. **Vitex negundo** Linn. var. **incisa** (Lamk.) C. B. Clarke, in Fl. Brit. India 4: 584, 1885; Birdwood, 22.

V. incisa Lamk. Dict. 2: 611. 1788; Bot. Mag. t. 364. 1797.

V. negundo f. *intermedia* Pei. Mem. Sci. Soc. China 1(3): 105-106, 1932.

V. negundo var. *intermedia* (Pei) Mold., Revist. Sudam. Bot. 5: 3, 1937 & Phytologia 6: 16, 1957.

This variety is quite common as a hedge plant and it could be distinguished from its typical variety due to its serrate margined leaves.

FLOWERS: Throughout the year.

LOCAL NAME: Katri Lingar.

* **Premna nimmoniana** Graham, Cat. Bombay Pl. 155, 1839; Cooke, T. 2: 427 (2: 507) (Doubtful and unknown species).

"Table lands, Mahabaleshwar and on way to Rotunda Ghat, leaves alternate" Graham.

The identity of this taxon by Graham which remained doubtful for so many years mainly due to the non-availability of Dr Murray's specimens, is cleared by Dr D. J. Mabberly (BOTANY AND HISTORY OF HORTUS MALABARICUS, edited by K. S. Manilal. p. 88, 1980). His comments on the identity of the species and the new combination is produced below:

"This is a description of the Goora or Kal-goora, collected by Dr Murray. I can find no specimen at Kew or British Museum (Natural History). Indeed, the identity of Murray is obscure: Mr Desmond commented, "In the 1930s there were two Murrays on the Bombay Medical Establishment, both assistant surgeons; James Murray at the convalescent Hospital, Mahabaleshwar and Andrew Murray serving with a European Regiment." I have no idea what happened to the collections. Nevertheless, the tree described is clearly that currently known as *Nothopodytes foetida* (Wt.) Slender, which therefore needs a new name:

Nothopodytes nimmoniana J. (Graham) Mabberly."

LABIATAE

1. Perfect stamens 2 .... *Salvia*
1. Perfect stamens 4 2
 2. Stamens declinate 3
  3. Attachment of nutlets basal, at the base of the calyx 4
   4. Lower lip of corolla deflexed, boat-shaped or saccate, much longer than the upper lip 5
    5. Calyx equally 5-toothed .... *Plectranthus*
    5. Calyx very oblique, 2-lipped .... *Anisochilus*
   4. Lower lip of corolla, declinate, flat, hardly longer than upper lip... *Ocimum*
  3. Attachment of nutlets dorsal..... *Lavandula*
 2. Stamens erect, spreading or ascending....... 6
  6. Corolla lobes 4: stamens equal or subequal 7
   7. Calyx 5-partite, lobes plumose; stamens inserted .... *Colebrookia*
   7. Calyx 5-toothed, segments not plumose; stamens exserted 8
    8. Leaves whorled .... *Eusteralis*
    8. Leaves opposite .... *Pogostemon*
  6. Corolla 2-lipped; stamens didynamous.... 9
   9. Upper pair of stamens longer.... *Nepeta*
   9. Lower pair of stamens longer........ 10
    10. Calyx 13-nerved ...... *Micromeria*

10. Calyx 5-10 nerved 11
    11. Upper lip of corolla short, nearly flat .... *Anisomeles*
    11. Upper lip of corolla hooded 12
        12. Upper lip of corolla densely woolly .... *Leucas*
        12. Upper lip of corolla not woolly ...... *Scutellaria*

Anisochilus Wall.

1. **Anisochilus verticillatus** Hook. f., in Fl. Brit. India 4: 629, 1885; Cooke, T. 2: 451 (2: 532); S. K. Mukerjee, in Rec. Bot. Surv. India, 14(1): 59, 1940; Puri & Mahajan, 130.

A rare species at Mahabaleshwar, known from only one collection. Corolla of this specimen is described as dirty white, whereas corolla in typical plant is pale blue.

FLOWERS: October.

Anisomeles R. Br.

1. Flowers white or creamy yellow; leaves membranous, glabrous or sparsely hairy *A. heyneana*
1. Flowers reddish purple; leaves thick, pubescent or woolly .... *A. indica*

1. **Anisomeles heyneana** Benth., in Wall. Pl. As. Rar. 1: 59, 1830; Dalz. & Gibs. 210; FBI 4: 672; Birdwood, 22; Cooke, T. 2: 460 (2: 543); Mukherjee, 152; Puri & Mahajan, 130.

A common shrub along forest paths. Leaves emit strong odour of essential oils.

FLOWERS: October-February.

LOCAL NAME: Chandhara.

2. **Anisomeles indica** (Linn.) O. Kuntze, Rev. Gen. Pl. 2: 512, 1891; Mukherjee, 152.

Nepeta indica Linn. Sp. Pl. 799, 1753.

A. ovata R. Br., in Ait. Hot. Kew. ed. 2, 3: 364, 1811; Graham, 153; Dalz. & Gibs. 210; Wight, Icon. t. 865, 1845; FBI 4: 672; Birdwood, 22; Cooke, T. 2: 461 (2: 543); Puri & Mahajan, 130.

Ajuga disticha Roxb., Fl. Ind. 3: 2, 1832; Cooke, T. 651, 1885.

A rare species at Mahabaleshwar.

FLOWERS: August-October.

LOCAL NAME: Gopali.

Colebrookea Sm.

1. **Colebrookea oppositifolia** (Poir.) Smith, Exot. Bot. 2: 111, t. 115, 1805; FBI 4: 642: Birdwood, 22; Cooke, T. 2: 459 (2: 541); Talbot 2: 365; Mukherjee, 84; Puri & Mahajan, 130.

Escholtzia oppositifolia Poir.. Dict. suppl. 5: 663, 1817.

C. tenuifolia Roxb., Cor. Pl. 3: 40, t. 245, 1819; Graham, 150; Dalz. & Gibs. 209; Cooke, T. 649, 1885; Lisboa, 220.

Common in clearings of forest and also along forest paths.

FLOWERS: January-March.

LOCAL NAMES: Bhaman, Bamni.

**Eusteralis* Rafin.

1. Plants less than 25 cm. tall......... *E. tomentosa*
1. Plants over 30 cm. tall........... *E. tomentosa* var. *gracilis*

* N. C. Majumdar (l.c.) seems to have accepted this genus for species with verticillate leaves, based on the comments of Bakhuizen van der Brink and van Steenis (*Taxon* 17: 235-6, 1968) that *Eusteralis* Rafinesque (FL. TELLUR 2: 95, 1836) is the existing synonym of *Dysophylla* sens. auct., based on *Eusteralis pumila* (Graham) Rafin. (Basionym: *Mentha pumila* Graham, 1828). Secondly, complete omission of reference to the Taxonomic Treatment of species of *Dysophylla* by S. K. Mukherjee [A revision of the Labiatae of the Indian Empire, in *Rec. bot. Surv. India* 14(1), 1940], suggests that Majumdar's studies are neither based on critical work on Indian material nor he has well surveyed the literature on the subject, but has based on a few remarks available in TAXON, and on personal communications and presumptions.

Following J. D. Hooker (FL. BRIT. INDIA 4: 640, 1885), Majumdar has reduced *Mentha pumila* Graham (*Edinb. New Phil. Journ.* 393, 1828) to the varietal rank of *Dysophylla crassicaulis* Benth. (Wall., *Pl. As. Rar.* 1: 30, 1830). However in *pumila-crassicaulis* complex, *M. pumila* Graham has priority. Since earlier authors consider them as allied varieties, we propose a new combination for *D. crassicaulis* Benth. as: *Eusteralis pumila* (Graham) Rafin. var. *crassicaulis* (Benth.) comb. nov.

1. **Eusteralis tomentosa** (Dalz.) Majumdar, in Journ. Bombay nat. Hist. Soc. 74: 385, 1978.

Dysophylla tomentosa Dalzell. Hook. Kew Journ. 2: 337. 1850; Dalz. & Gibs. 208; Keng. Gard. Bull. Straits Settlm. 24: 71, 1969; K. N. Gandhi. in Fl. Hassan Dist. 500, 1976.

A common herb, often gregarious in drying ricefield and along water courses. When the plant is in bloom the whole ground covered by this plant looks like a mat of bright purple colour from a distance.

FLOWERS: November-January.

According to Keng (l.c.), Bentham, while describing this species, used basionym *Mentha stellata* Lour. (FL. COCHINCH. 2: 361, 1790) for this species, which is a distinct species. Therefore Bentham's name becomes superfluous for this taxon and has to be rejected.

2. **Eusteralis tomentosa** (Dalz.) Mazumdar, var. **gracilis** (T. Cooke) comb. nov.

Dysophylla stellata var. *gracilis* (Dalz.) T. Cooke. in Fl. Pres. Bombay 2: 458. 1906; Mukherjee 81.

D. gracilis Dalz.. in Hook. Kew Journ. Bot. 2 : 337. 1850; Dalz. & Gibs. 208; FBI 4: 641; Cooke T. 651; Birdwood, 22.

D. erecta Dalz.. in Kew Journ. Bot. 2: 337. 1850: Dalz. & Gibs. 208; FBI 4: 641.

This is the more common variety at Mahabaleshwar, growing in the same habitat as that of typical variety, from which it differs in having slender habit sometimes reaching to 2-3 feet in height. We follow Dr S. K. Mukherjee, who in his MONOGRAPH ON LABIATAE OF INDIAN EMPIRE considers it as a variety of *D. stellata* Benth., which is the superfluous name of the typical variety.

Lavandula Linn.

1. **Lavandula gibsoni** Graham, Cat. Bombay Pl. 149, 1839; FBI 4: 631, Birdwood, 22: Cooke, T. 2: 451 (2: 533-4); Mukherjee, 64.

L. perrottetii Benth.. in DC. Prodr. 12: 147. 1848; Dalz. & Gibs. 206; Santapau. Fl. Purandhar. 108. 1958.

L. lawii Wt., Icon. t. 1439, 1850.

There is one specimen of this species in Blatter Herbarium collected by Asrana from Mahabaleshwar. We have not seen this plant on the plateau. However, it is quite common between Wai and Panchgani. Asrana's specimen might have come from that ghat on his way to Mahabaleshwar.

FLOWERS: February.

LOCAL NAME: Nivale.

Leucas R. Br.

1. Calyx mouth oblique 2
   2. Calyx smooth .... *L. linifolia*
   2. Calyx villouse within ....*L. cephalotes*
1. Calyx mouth straight 3
   3. Calyx teeth slender. ciliate. 10 mm. long or longer .... *L. ciliata*
   3. Calyx recurved. very short. 5-9 mm. long .... *L. stelligera*

1. **Leucas ciliata** Benth., in Wall. Pl. As. Rar. 1: 61, 1829; Dalz. & Gibs. 211; Lee, 625; FBI 4: 687; Cooke, T. 651, 1885 & 2: 471 (2:554); Birdwood, 23; Puri & Mahajan, 130; Santapau, 298, 1963.

Very common and abundant herb along road-sides in exposed lands.

FLOWERS: September-March.

LOCAL NAMES: Bhurumbi, Bhuram.

2. **Leucas cephalotes** Spreng. Syst. 2: 743, 1825; Graham, Cat. 153; Dalz. & Gibs. 211; FBI 4: 689; Wight, Icon. t. 337, 1840.

A rare species at Mahabaleshwar in partially shady places.

FLOWERS: October-November.

3. **Leucas lavandulaefolia** J. Smith, in Rees, Cycl. 20: No. 2, 1819; Mukherjee, 67: Santapau, Fl. Khandala, ed. 3, 219.

L. linifolia Spreng.. Syst. 2: 743, 1825; FBI 4: 690; Cooke, T. 2: 465 (2: 548).

Rare herb in cultivated fields. More prominent after harvests of crops.

FLOWERS: September-November.

LOCAL NAME: Goma.

4. **Leucas stelligera** Wall. ex Benth., in Wall. Pl. As. Rar. 1: 61, 1829; Dalz. & Gibs. 211; Lee, 625; FBI 4: 686; Cooke, T. 651, 1885 & 2: 470 (2: 553-4); Lisboa, 220; Birdwood, 23; Mukherjee 177; Puri & Mahajan, 130; Santapau, 401, 1962.

A very common and abundant weed all over in open ground.

FLOWERS: October-May.

LOCAL NAME: Goma.

Mentha Linn.

Mentha spicata Linn. Sp. Pl. 576, 1753.

Mentha viridis Linn. Sp. Pl. ed. 2. 804. 1763: FBI 4: 647; Cooke. T. 2: 475 (2: 559).

This also is cultivated for its scented leaves.

LOCAL NAME: Pudina.

Micromeria Benth.

1. **Micromeria capitata** Benth., in DC. Prodr. 12: 218; 1848; FBI 4: 649; Birdwood, 23; Woodrow, Journ. Bombay nat. Hist. Soc. 12: 362, 1899; Cooke, T. 2: 459 (2: 542); Mukherjee, 97.

M. malcomiana Dalz.. in Dalz. & Gibs. Bombay Fl. 209, 1861; Cooke. T. 651. 1885; Lee. 625; Lisboa, 220.

A rare endemic species found abundantly near Yenna Lake.

FLOWERS: April.

Ocimum Linn.

1. **Ocimum sanctum** Linn. Mant. 1: 85, 1767; Graham, 147; Dalz. & Gibs. 204; FBI 4: 609; Cooke, T. 2: 439 (2: 521).

Commonly cultivated in front of Hindu houses as a sacred plant. Occasionally found growing wild in waste-lands.

FLOWERS: Throughout the year.

LOCAL NAME: Tulas.

Plectranthus L'Herit

1. Annuals, 30-60 cm. tall; calyx with minute red glands; stamens exserted .... *P. stockii*
1. Perennials, 1-2 metre or more tall; calyx without red glands; stamens included....... *P. japonicus*

1. **Plectranthus japonicus** (Burm. f.) Koidzumi, in Bot. Mag. Tokyo, 43; 386, 1929; Santapau & Wagh, Bull. Bot. Surv. India 5(2): 107.

Scutellaria japonica Burm. f.. Fl. Ind. 130. 1768.

P. coesta Buch.-Ham. ex D. Don. Fl. Nepal. 117, 1825; FBI 4: 619; Cooke. T. 2: 447 (2: 529); Mukherjee. 44.

P. menthoides Benth.. in Wall. Pl. As. Rar. 2: 17. 1830; FBI 4: 620.

Occasional, along roadsides in open grounds, near streams and on forest fringes.

FLOWERS: December-June.

2. **Plectranthus stocksii** Hook. f., in Fl. Brit. India, 4: 618 1885; Cooke, T. 651 & 2: 446 (2: 528); Mukherjee, 43; Puri & Mahajan, 130; Santapau, 400, 1962.

P wightii Graham. Cat. Bombay Pl. 148. 1839; (non Benth.. 1831); Dalz. & Gibs. 205; Birdwood 22.

Fairly common and abundant along roadsides in shady places and among the undergrowth in the forests.

FLOWERS: September-October.

Pogostemon Desf.

1. Shrubby perennials 2
   2. Stems glabrous .... *P. benghalensis*
   2. Stems pubescent or villose .... *P. parviflorus*
1. Annual herbs 3
   3. Bracts linear-oblong; corolla tube included .... *P. myosuroides*
   3. Bracts lanceolate; corolla tube exerted.......4
      4. Leaves with rounded bases .... *P. auricularia*
      4. Leaves with acute bases .... *P. salicifolia*

1. **Pogostemon auricularia** (Linn.) El-Gazar & Watson. Taxon. 16: 186. 1967.

Dysophylla auricularia Blume, Bijdr. 826, 1825; Graham, 150; Wight, Icon. t. 1445, 1850; FBI 4: 638; Cooke, T. 2: 457 (2: 538-9).

Mentha auricularia Linn., Mant. Pl. 81, 1767.

This species is reported here on the authority of Graham, who mentions it from Mahabaleshwar. According to T. Cooke, Graham might have mistaken *Dysophylla salicifolia* Dalz. for this taxon.

2. **Pogostemon benghalensis** (Burm. f.) Kuntze, Rev. Gen. Pl. 529, 1891; Santapau, Fl. Khandala, ed. 3, 217.

Origanum benghalense Burm. f., Fl. Ind. 128, t. 38, f. 3. 1768.

P. plectranthoides Desf., Ann. Mus. Natl. Hist. Nat. 2: 156, t. 6. 1808; Dalz. & Gibs. 207; Bot. Mag. t. 3238, 1833; FBI 4: 632; Cooke, T. 2: 453 (2: 536).

Common all over the plateau on exposed rocky ground.

FLOWERS: December-April.

3. **Pogostemon myosuroides** (Roth.) El. Gazar & Watson, in Taxon, 16: 186, 1967.

Dysophylla myosuroides Benth., in Wall. Pl. As. Rar. 1: 30, 1830; Dalz. & Gibs. 208; Lee, 625; Cooke. T. 651 & 2: 456 (2: 538); Birdwood. 22; FBI 4: 638; Puri & Mahajan, 130.

Mentha myosuroides Roth., Nov. Pl. Sp. 257, 1821.

A rare species in wet places and along watercourses.

FLOWERS: January.

4. **Pogostemon parviflorus** Benth., in Wall. Pl. As. Rar. 1: 31, 1829; FBI 4: 632; Cooke, T. 2: 453 (2: 536); Birdwood, 22; Mukherjee, 68; Puri & Mahajan, 130.

P. purpuricaulis Dalz., in Hook. Kew Journ. Bot. 2: 336, 1850; Dalz. & Gibs. 207; Cooke, T. 649, 1885; Lisboa, 220.

P. frutescens Graham, Cat. Bombay Pl. 149, 1839.

A shrub in partially shaded places along forest borders.

FLOWERS: December-April.

LOCAL NAMES: Phangli, Pangli.

Salvia Linn.

1. **Salvia plebeia** R. Br., Prodr. 501, 1810; Dalz. & Gibs. 209; FBI 4: 655; Cooke, T. 651, 1885 & 2: 474 (2: 557); Birdwood, 23; Mukherjee, 111; Puri & Mahajan, 130.

A rare species at Chinaman's falls and in the Hindu Cemetery near Yenna Lake in moist ground.

FLOWERS: December-April.

LOCAL NAME: Birambola.

Scutellaria Linn.

1. **Scutellaria discolor** Coleb., in Wall. Pl. As. Rar. 1: 66, 1829; Dalz. & Gibs. 210; FBI 4: 667; Lee, 625; Birdwood, 23; Mukherjee, 146.

S. indica Blume, Bijdr. 839, 1826 (non Linn., 1753); Graham, Cat. 152.

This species is reported by Graham from Mahabaleshwar, Graham mentions colour of the flowers to be white which makes the identity of Graham's plant rather doubtful. We have seen this plant elsewhere only in blue-purple flowers. We have neither seen this at Mahabaleshwar or in any herbarium, nor collected it from the localities under study.

(to be continued)

A CATALOGUE OF THE BIRDS IN THE COLLECTION OF BOMBAY NATURAL HISTORY SOCIETY-29

MUSCICAPIDAE

(Muscicapinae, Pachycephalinae)

HUMAYUN ABDULALI

[*Continued from Vol.* 80(2): 369]

1124 specimens of 75 species and subspecies are dealt with in this part. The last bird handled is Register No. 26338. Mr. Eric D'Cunha, Research Assistant at BNHS has continued to help on a whole time basis.

1402 **Rhynomyias brunneata nicobarica** Richmond (Great Nicobar) Olive Flycatcher 8:627

2 ♀♀ Campbell Bay, Great Nicobar.

Measurements on p. 104.

EL. **Muscicapa striata striata** (Pallas) (Netherlands) European Flycatcher

4: 2 ♂♂ 1 ♀ 1 o?

Isle of Wight, U.K.

4 birds from the Isle of Wight were marked as *Muscicapa grisola* (*striata*) with a J. L. Bonhote Coll. label. In one instance the label had been accidentally transferred to a specimen of *M. sibirica* (with no other label) but has now been put back on to a *striata* with no label. The coir stuffing as in the other three and also a piece of red thread on the leg, present only in one other from the same place, confirm the error.

Measurements on p. 104.

1403/1404 **Muscicapa striata sarudnyi** (Eastern Iran and Transcaspia) Spotted Flycatcher 2 : 202

24 : 9 ♂♂ 4 ♀♀ 11 o?

2 *R. Tanhat, Yemen;* 1 *Fahama, Baghdad,* 2 *Basra,* 1 *Shaiba,* 2 *Feluja, River Euphrates,* 1* *Sheikh Saud,* 1* *Fao, Persian Gulf;* 1 Hajarganj (27° 28′ N, 66° 10′ E) Baluchistan; 1 Chitral Sanatorium, 1 Gilgit, 1 Karachi, Pakistan; 1 Sakesar, Saharanpur, Punjab; 2 Bhuj Fort, 3* Manjal, Nakhatiana dist., Kutch; 1 Dhari, Amreli dist., 2 Dwarka, Okhamandel. 1 Victoria Park, Bhavnagar, Kathiawar.

5 marked (*) are slightly darker above and marked *neumanni* by Sálim Ali and Ticehurst but this race is now synonymised with *sarudnyi*.

Measurements on p. 104.

1405 **Muscicapa sibirica gulmergi** (Baker) (Gulmerg, Kashmir) Kashmir Sooty Flycatcher 2:205

23: 15 ♂♂ (4 juv.) 3 ♀♀ (1 juv.) 5 o?

1 7500′, Baradam; 1 Chitral; 1 Gilgit; 1 Mogul Maidan, Kishtwar, 1 Yusmarg, 2 Lidar Valley, 1 Kashmir; 10 Simla; 1 Garhwal, Kumaon; 1 Bhutan Duars; 1 *Sulor, S. Tibet;* 1 *Nyaunggyo, Prome dist.; Burma;* 1 no data.

The bird from Burma was marked *cacabata* by Sálim Ali many years ago, but this has been cut out and replaced by *gulmergi* by Ticehurst.

In IND. HAND. (7, p. 143) reference is made to *M. latirostris* being separable from *sibirica* by the latter's folded wing almost reaching the tip of the tail as against a larger gap of 15 mm in *latirostris.* In specimens available, this character holds good for the subspecies *sibi-*

rica and *cacabata* only, the gaps being 4.5 to 8.8 mm, av. 6 and 8 to 8.5 mm respectively, but 8.5 to 25, av. 15.4 in *gulmergi.* The pinkish-buff inner webs of the tertials referred to in the key on p. 140 (l.c.) in all races of *sibirica* and the distinctly broader bill in *latirostris* appear to be more certain characters between the species.

Measurements on p. 104.

1406 **Muscicapa sibirica cacabata** Penard (Nepal) Nepal Sooty Flycatcher 2:205

2: 1 ♂ 1 o?

1 Gedu. West, 1 Shamgong, Central Bhutan.

Both show darker above than *gulmergi* and the nominate form.

♂ No. 25183 from Shamgong, has the bill bent over, showing an unusual curve.

Measurements on p. 104.

EL. **Muscicapa sibirica sibirica** (Gmelin) (Lake Baikal) Siberian Sooty Flycatcher

7: 3 ♂♂ (1 juv.) 3 ♀♀ 1 o?

All *Temple of Heaven, Peking, China* (Major H. A. Walton, 1901). This race with the greater amount of white on the underparts is more easily distinguishable than the others. The specimens also appear larger than suggested by the measurements.

Measurements on p. 104.

1407 **Muscicapa latirostris** Raffles (Sumatra) Brown Flycatcher 2:248

45: 18 ♂♂ 16 ♀♀ 11 o?

1 Solon, 1 Bhagat State; 1 Koti State, Simla Hills; 1 Gujiri, Dhar State; 1 Bigwar, Indore; 1 Waghai, Surat Dangs; 1 Bombay City, 1 Kihim, Alibag, 2 Khandala, Maharashtra; 4 Karwar, 1 Alanki, N. Kanara; 1 Bangalore, 1 Kolar, 1 Margimatta, Sagar, Karnataka; 1 Thattakad, North, 1 Rajanpara, 1 Merchistan (Ponmudi), South Travancore; 1 Cherangodu, Cherambadi; 1 Kottamalai, Gudalur, Nilgiris; 1 Point Calimere, Tanjore Dt., Tamil Nadu; 1 Chitteri Range; 1 Kala Vaghu, Shri Harikota; 2 Sheshachalam Hills, S. Cuddapah, 1 Nallamalai, S. Kurnool; 1 Lamasinghi, 1 Upper Sileru, Vizagapatnam; 1 Bamboo Flats, 1 Chirria Tapu, 1 Betapur, 1 Long Island, M. Andamans, 2 S. Andamans; 2 Car Nicobar; 1 Camorta, Central Nicobars; 1 Narcondam Island; 1 *Singapore*; 3 *Temple of Heaven, Peking, China.*

The birds show considerable variation in the amount of grey and white on the underparts, but with the material available it is not possible to isolate any group. Koelz (JBNHS 43, p. 16) draws attention to these variations and rightly says that it will only be possible to understand their significance when breeding material is available. ♀ No. 4158 from Thattakad, N. Travancore, collected on 3 Feb., 1933 has the bill noticeably smaller than in all the others. In some, the legs and feet have dried pale brown, but most are dark *contra* yellow in *muttui.* While it is accepted as a winter visitor over most of India, there are breeding records in peninsular India. Perhaps there is a resident and a migrant race, but suitable series must be available to decide if they are different.

Measurements on p. 104.

1408 **Muscicapa muttui muttui** (Layard) (Pt. Pedro, Ceylon) Brownbreasted Flycatcher 2:251

13: 6 ♂♂ 3 ♀♀ 4 o?

4 Molem, Goa; 1 Gersoppa (Jog Falls), Shimoga dt.; 1 Saklespur, Hassan dt., Karnataka; 1 Wynaad; 1 Thattakad, 1 Urumbikera Reserved Forest, Mundakayam, 1 Merchistan (Ponmudi), South Travancore; 2 Point Calimere, Tanjore dt. Tamil Nadu; 1 Ceylon.

Two specimens of *M. latirostris* were included with this species. Apart from other differences the black, *contra*, yellow, legs are distinctive.

Measurements on p. 105.

1409 **Muscicapa ruficauda** Swainson (India=Kashmir) Rufoustailed Flycatcher 2 : 250

15: 5 ♂♂ (1 juv.) 6 ♀♀ 4 o?

1 Chitral Sanatorium. 1 Chitral, Pakistan; 2 Lidar Valley, 1 Dachigam, 1 Naglal, 3 m. below Yusmarg, 1 seven miles below Yus, near Chasm-i-Sherif, Kashmir; 1 Gama-Ki-hatti, Dharni State, 1 Patiala State, 1 Kufri, Koti State, 4 Simla. N. W. Himalayas; 1 Ponmudi, (Merchistan) S. Travancore.

Measurements on p. 105.

1410 **Muscicapa ferruginea** (Hodgson) (Nepal) Ferruginous Flycatcher 2:206

2 o?

1 *Sima. Upper Burma;* 1 6000' *Mt. Victoria, Burma.*

Sp. 391 from Mt. Victoria, collected by K. C. Macdonald is marked "Shot off nest with 3 set eggs. Nest of moss on fork of horizontal branch 30 ft up on bank of stream 13-5-06".

Measurements on p. 105.

1411 **Muscicapa parva parva** Bechstein (Thuringerwald) Western Redbreasted Flycatcher 2:210

62: 40 ♂♂ 18 ♀♀ 4 o?

(a) 5 ♂♂ with dark rufous on breast;

1 Bahawalpur; 1 Bharatpur; 2 Satara. Maharashtra; 1 Baghowni, Bihar.

(b) 18 ♂♂ with a little rufous on breast;

1 Chitral; 1 Patiala State. N. W. Himalayas, 1 Lalru, 4 Ambala, 1 Ladwa, Kanal dt., Punjab; 1 Delhi, 1 Harunabad, 1 Bahawalpur; 1 Lakput, Kutch, 1 Karaghoda. Gujarat; 1 Nasik, 1 Ambernath. Kalyan, 1 Nagotna. Kolaba. 1 Pt. Calimere, Tamil Nadu; 1 no data.

(c) 39: 17 ♂♂ in ♀ plumage. 18 ♀♀ + 4 o? All in similar plumage.

1 Chitral Drosh. Pakistan; 2 Simla. N. W. Himalayas; 1 Ladwa. Kanal dt.. 1 Ambala, Punjab; 2 Delhi; 1 Hamavas Lake, Pali dt., Jodhpur, 1 Bharatpur, Rajasthan; 1 Bahawalpur town environs; 1 Dalkhonia, Amreli Dist., 1 Khoda, Pacham Is., 1 Dholavira, Khader Is., 1 Lakhput. Kutch; 1 Jambughoda, Gujarat; 1 Pandwa, 1 Laschoti. Surat Dangs. Gujarat; 1 Kuno, Gwalior State, 1 Mathar, Narbada Valley, C.I.; 1 Sonwani. Balaghat Div., 1 Chota Dongar, Bastar, C. P.; 1 Nasik, 1 Pali Hill. Bandra. 1 Khandala. 1 Panchgani, 1 Mehda, Satara, Maharashtra; 1 Anantgiri. 1 Upper Sileru, Visakhapatnam. 1 Badrama. Bamra. 2 Koira. Bonai. 1 Ranipathar. Phulbani dt., Orissa; 3 Meerut, 1 Cawnpore. 1 Philibit Terai, U.P.; 1 Lodrai, C. Bhutan; 1 North Cachar.

Measurements on p. 105.

1412 **Muscicapa parva albicilla** Pallas (Dauria) Eastern Redbreasted Flycatcher 2:211

32: 18 ♂♂ 10 ♀♀ 4 o?

(a) 10 ♂♂ with rufous chin and throat:

1 Cawnpur; 1 Phulbani. Orissa; 3 Shillong. Assam; 5 *Temple of Heaven, Peking, China.*

(b) 1 ♂ with little rufous on chin: 1 Madhubani, Bihar.

(c) 21: 7 ♂♂ in ♀ plumage, 10 ♀♀ 4 o?

1 Murbad Road, Kalyan, Bombay; 1 Molem, Goa; 1 N. Kanara; 1 Bhanuprattapur. Kanker; 1 Sonwani. Balaghat. C.I.; 2 Baghowni. Darbhanga. Bihar; 1* Monayx (C. M. Inglis. Dec. 1903—Kumaon); 1 Ghazipur. U.P.; 1* Dibrugarh. 1 Shillong, Assam; 1 Narcondam Is.; 1 *N'Krang, Upper Burma*; 1 *Pankuang*, 1 *Nathmaw, Prome, Burma*; 6 *Temple of Heaven. Peking, China.*

Some of the identifications have been guided by notings of earlier workers, as also the geographical position of the places where obtained. Those marked * may well be *parva.*

As admitted by almost all previous workers in India, it is impossible to separate the young males and females of nominate *parva* and *albicilla*; even some of the males in full plumage are difficult to name, for they are badly damaged on the breast having been placed in shallow drawers in which the feathers were rubbed off when pulled open. The deeper colour of the upperparts of *albicilla* is not always visible for many have no doubt faded. It is also very doubtful if birds from India accepted as *albicilla* are the same as those from Peking which, though going back to 1901, have their chins a pale orange rather than the chestnut of Indian birds. BIRDS OF THE SOVIET UNION, VI, p. 126, refers to the "gular spot less bright with dimensions narrower. sometimes in form of longitudinal stripe".

This factor does not appear to have been referred to in Indian literature but shows in some of the males from Peking.

In addition, the Peking birds all have noticeably smaller bills, a character I have used in separating Indian birds as of this race, though they are not quite so small. On these differences the Chinese birds are easier to separate from those named *albicilla* from India, than several of the latter from those under *parva*.

The fact that eleven specimens of six other species *M. rubeculoides*, *M. latirostris*, *M. hyperythra*, *M. hodgsoni* and *M. subrubra* and *Rhyacornis fuliginosa* were registered as *parva* may be an indication of the confusing position.

Measurements on p. 105.

1413 **Muscicapa subrubra** Hartert & Steinbacher (Ceylon) Kashmir Redbreasted Flycatcher 2:212

7: 4 ♂♂ (1 *juv.) 2 ♀♀ 1 o?

2 Dachigam, 2 Kashmir; 1 Koti State; 1* Bumthang, E. Bhutan; 1 Pt. Calimere, Tamil Nadu.

In addition to the dark rufous chin and upper breast of the males being bordered black, the wing formula of 2nd primary being shorter than or equal to the 7th (which is shorter than the 6th) appears to be consistent. The key in IND. HANDBOOK 7, p. 139 requires that the 2nd primary in *subrubra* should be shorter than the 6th, but this character is shared with *parva*, and as indicated earlier, it should also be shorter than the 7th. It is correctly stated on p. 139 *loc. cit.* that the 2nd primary is equal to or shorter than the 7th, while in *parva* it is invariably longer. I had examined the matter earlier (JBNHS 71, p. 502), but inadvertently reversed the facts.

We have no juvenile *parva* for comparison but the specimen from Bumthang (10 October 1973) in addition to extending its distribution further east than so far recorded, is very dark and has an almost black tail. Of the two females, No. 23727 from Dachigam has no rufous in front, while No. 16810 from Koti State has an appreciable amount of rufous on the chin and breast, and is marked by A. E. Jones "Ovaries much enlarged. This is the first female personally noted in male plumage".

Measurements on p. 105.

1414 **Muscicapa strophiata strophiata** (Hodgson) (Nepal) Orangegorgeted Flycatcher 2 : 208

36: 21 ♂♂ 12 ♀♀ (1 juv.) 3 o?

1 Kufri, 1 Kalka, Koti State; 1 Tara-Devi, Patiala State, 1 Baghi Bushahr, 2 Simla; N. W. Himalayas; 1 Deoban, Jaunsor, Kumaon; 2 Sandakphaw, 1 Longview, 1 Tongloo, Darjeeling, 1 Rinchinpong, West, 1 Rangpo, 1 Martam, Rongni Valley, Sikkim; 2 Chimakothi, West, 3 Batase, 1 nr. Tongsa, 1 Shamgong, Central, 3 Deothang, 3 Gomchu, 2 Rongtong, 2 Bumthang, East Bhutan; 1 Ratana, 1 Dening, Mishmi Hills; 1 Kangpokpi, 1 Bishenpur, Manipur; 1 *Mt. Victoria, Burma.*

In 1939 Koelz described another series of new races from "Asia chiefly from India" and this included *emphonia* of this species from Kulu, Kangra Dist. and Arsu, Punjab, Chaura and Serahan, Simla Hills, which he said were generally paler, except for the throat. Whistler commenting on these races (JBNHS 43 p. 34) accepts this as definitely paler than those from the Eastern Himalayas. In IND. HANDBOOK 7 p. 158 and SYNOPSIS (1982) this is synonymised with the nominate race. The first seven (3 ♂ ♂ 4 ♀ ♀) in the above list do have their upperparts a paler brown than in all the others, and among them No. 16805 from 6600 ft. Simla marked adult ♀, is a very pale rufous or light brown on the chin, neck and breast and shows no grey below as in the others.

If No. 16805 from Simla is representative of a resident population, and the others are non-

breeding migrants then it is certainly different and deserves recognition. The paleness of the upperparts may be due to fading.

The seven eastern females have grey and not black chins, within a very small and pale orange gorget. Excluding the very pale bird (16805) the two western females have the gorget as dark as in the males as also a black chin and throat. No. 3916 ♀ juv. from Darjeeling is spotted like other flycatchers and the Simla bird is probably an undescribed immature phase.

Measurements on p. 106.

1415 **Muscicapa monileger monileger** (Hodgson) (Nepal) Himalayan Whitegorgetted Flycatcher 2:244

1 ♀ Kalaktang, Western Arunachal Pradesh.

In addition to the rufous on the forehead *contra* white in the next (1416), the tail appears to be more rufous than in that form.

Measurements on p. 106.

1416 **Muscicapa monileger leucops** (Sharpe) (Shillong) Assam Whitegorgetted Flycatcher 2:245

3 ♀♀

1 Miao, 2 Embiong, Tirap, Arunachal Pradesh.

Measurements on p. 106.

1417 **Muscicapa hyperythra hyperythra** Blyth (Darjeeling) Rufousbreasted Blue Flycatcher 2:217

28: 18 ♂♂ (3 by plumage) 8 ♀♀ 2 o?

1 Dakuri, Kumari; 1 *Shama, Chembo* 7000′ *S. Tibet;* 5 Gedu, 2 Honka, West, 4 Mangdechu, 3 Shamgong, 2 Tama, Central Bhutan; 1 Goma Reserve, Goalpara; 1 Dening, Lohit Valley; 4 Margherita, Assam; 1 Miao, 2 Hornbill Camp, Tirap div., Arunachal Pradesh; 1 *Mt. Victoria, Burma.*

The blue of the upperparts fades away in a few years. It is deepest in No. 26318 dated 8 Dec. 1981 from Hornbill Camp.

Measurements on p. 106.

1418 **Muscicapa hodgsonii** (Verreaux) (Chinese Tibet-Paohing, Eastern Sikang) Rusty-breasted Blue Flycatcher 2:216

6: 3 ♂♂ (one in ♀ plumage) 1 ♀ 2 o?

1 Kurseong, Darjeeling; 1 Chamakothi, West, 2 Shamgong, 1 Tama, Central Bhutan; 1 *Mindon Yoma, Thayetmyo, Burma.*

Measurements on p. 106.

1419 **Muscicapa westermanni collini** Rothschild (Nepal, Darjeeling) Western Little Pied Flycatcher 2:224

3: 2 ♂♂ 1* o? (juv.)

1 Chahala Simlipal Hills, Orissa; 1 Pilibhit Terai, U.P.; 1* Dhanaulti, Mussoorie.

The two males cannot be distinguished from those of the next form (1420) and the identification is distributional. The unsexed juvenile (26 June, 1974) with the usual spotting of flycatchers is quite different from the juvenile of the next race, being lightly spotted with greyish white on a greyish background while the other is more heavily spotted with rich ochraceous. The absence of both white in the tail and of black and white in the wing suggests a female. The primaries in the juvenile of the next form Sp. No. 4028 are black with the outer edges to the tertiaries marked with white. The base of the black tail is white. This may well be the difference between the male and female juveniles but the first is unsexed and the latter collected at Shillong by Stuart Baker is marked ♀ ! The specimens and literature available do not permit any further remarks.

Measurements on p. 106.

1420 **Muscicapa westermanii australorientis** Ripley (Phou Kobo, Laos) Eastern Little Pied Flycatcher 2 : 224

21: 14 ♂♂ (3 by plumage), 7 ♀♀ (1 juv.)

1 near Phuntsholing, West, 3 Tama, 2 Batase,

Central, 4 Rongtong, 1 Gomchu. East Bhutan; 1 Goma Reserve, Goalpara; 1 Sadiya. 1 Margherita. 2 Shillong, Assam; 2 Miao. Tirap Div.. Arunachal Pradesh; 1 Bagho Bahar, Cachar; 1 *N. Shan States*, 1 *Kamaing, U. Burma.*

See remarks under 1419 regarding juvenile marked ♀ in plumage resembling ♂.

Measurements on p. 106.

1421 **Muscicapa superciliaris superciliaris** Jerdon (Ajunta, N. Ghats) Whitebrowed Blue Flycatcher 2:221

41: 27 ♂♂ (2 juv. by plumage) 10 ♀♀ 4 o?

1 Dalhousie. 16 Simla. 2 Almora, Himachal Pradesh; 1 Ambala, Punjab; 1 Mussoorie. 1 Pandukeshwar. 1 Terguji. Narayan. 2 Ramni. 2 Lambathach. 1 Yoshinath, Garhwal. 1 Dakuri, Kumaon, U.P.. 2 Darba, 1 Kameli, Bailadila, 1 Chota Dongar*, Bastar; 1 Sonawani, Balaghat, C. P.; 1 Raipur, Melghat. 1 Chikalda. Berar; 1 Molem, Goa; 1 Shankrametta* Vizagapatnam. A.P.; 1 Mahendragiri. 1 Koiva (Bonai), 1 Orissa. * missing.

Two chicks in juvenile plumage (1st June and 18th July) have the basal portion of the outer tail feathers white, a character presumably restricted to the male, though ♀ 15857 from Ambala also has half of the outer tail feather white. ♀ 15857 referred to above is one of the three with blue on the tail. After the spotted phase the male acquires blue on the tail which spreads upwards, finally reaching the head. The number of specimens is insufficient to table these changes date-wise.

Measurements on p. 107.

1422 **Muscicapa superciliaris aestigma** Gray (Nepal) Little Blue-and-White Flycatcher 2: 223

3: 1 ♂ 2 ♀♀

1 *Salumba, S. Tibet*; 1 Mangdechu. Central Bhutan; 1 Naga Hills.

The male lacks the white eye stripe and the white at the base of the tail feathers. The females are smaller than those of the nominate form. Biswas (JBNHS 59. pp. 810-812) discusses the validity of the name *aestigma* and relevant matters.

Measurements on p. 107.

1423 **Muscicapa leucomelanura leucomelanura** (Hodgson) (Nepal, Central Hills) Western Slaty Blue Flycatcher 2 : 219

15: 7 ♂♂ 4 ♀♀ 4 o? (1 juv.)

1 Yusmarg, 1 Maw Padar, Kishtwar; 4 Kashmir; 2 Simla. 1 Kufri, Koti State, 1 Kalka, 1 Bhagat State. 1 Chandigarh. 1 Thanesa, Kamal Dist., 1 Ambala, Punjab. 1 Darbhanga. Bihar.

Measurements on p. 107.

1424 **Muscicapa leucomelanura minuta** (Hume) (Mount Tongloo, Sikkim) Eastern Slaty Blue Flycatcher 2 : 219

10: 4 ♂♂ 6 ♀♀

1 Bhutan Duars; 1 nr. Phuntsholing, 5 Gedu, 1 Honka, West Bhutan; 1 Kaziranga. Assam; 1 Firm Base. Tirap Div.. Arunachal Pradesh.

Measurements on p. 107.

1425 **Muscicapa leucomelanura cerviniventris** (Sharpe) Manipur Slaty Blue Flycatcher 2 : 220

1 ♂ (by plumage) *Mt. Victoria.*

Measurements on p. 107.

1426 **Muscicapa sapphira sapphira** (Blyth) (Darjeeling) Sapphireheaded Flycatcher 2: 225

12: 9 ♂♂ (1* missing) 3 ♀♀ (2 by plumage, 1 missing).

1 Longview T.E.. Darjeeling; 1 Kalijpora, 1 Berrick. 1* Pershoke, 1* Martam, Rongni Valley, 3 Rangpo. Sikkim; 1 Gedu. West Bhutan, 1 Margherita. Assam; 1 Deban Dist. Arunachal Pradesh; 1 *Htawgaw, Upper-Burma.*

Of the 8 available males only one from Htawgaw, Upper Burma is in adult plumage. ♂ No. 4035 from Darjeeling has the chin darker than in the others. Nos. 25193 and 26338 from Deban, Arunachal Pradesh and West Bhutan. doubtfully sexed have their

breasts paler orange-rufous and have been put down as females in which the upper and lower parts are different from subadult males. The absence of the only definitely sexed female prevents any decisions.

Measurements on p. 107.

1427 **Muscicapa nigrorufa** (Jerdon) (Nilgiris) Black-and-Orange Flycatcher 2: 253

19: 13 ♂♂ (2 juv.) 6 ♀♀

2 Honnametti T. E., 2 Bellaji, Billigirirangan Hills; 3 Avalanche, 1 Naduvattam, 1 Mullumund, 2 Marappalam, 1 Upper Bhavani, Nilgiris; 2 Munnar, Travancore; 3 Kodaikanal, 2 Shembagnur, Palnis.

2 ♂♂ from the Nilgiris (one marked ad. ♂) have their heads and wing-coverts olive-brown as in the females and unlike the black of the adult males. All six females have the tertiaries finely bordered with rufous, a character missing in the young males. The dry bills of the females and the young males appear to be less black than in the males.

Measurements on **p. 107.**

1428 **Muscicapa grandis grandis** (Blyth) (Darjeeling) Large Niltava 2 : 257

27: 18 ♂♂ (2 juv.) 9 ♀♀

1 Sipuri. Nepal; 1 Kurseong, 2 Jorepothi. Darjeeling Dt.; 2 Temi. 1 Rinchinpong. West, 1 Ringli. Ringliot, Sikkim; 3 Shamgong, 2 Batase, 1 Ganglipokti, 1 Mangdechu. Central, 1 Wamrong, 1 Rongtong. 1 Deothang, East Bhutan; 2 Margherita, Assam; 1 Miao, 1 Embiong. 1 Hornbill Camp, Tirap Div., Arunachal Pradesh; 1 Kohima. Nagaland; 1 Kangpokpi. Manipur; 1 Guilang. N. Cachar; 1 *Mt. Victoria, Burma.*

Almost all the males show slight white tips to their under tail-coverts forming white bars in some. IND. HANDBOOK (7: 176) refers to the belly being purplish black, but this colour is not visible in any of the specimens, the most recent having been obtained two years ago.

Measurements on p. 108.

1429 **Muscicapa macgrigoriae macgrigoriae** (Burton) (Himalayas, restricted to Western Himalayas) Western Small Niltava 2: 260

5: 4 ♂♂ 1 ♀.

1 Mandal, Chameli, Garhwal; 2 Ranibagh, Kumaon; 2 Longview Tea Estate, Darjeeling, Bengal.

The material available is barely separable into a pale and a dark race, but has been divided on geographical grounds. The juvenile was listed in *M. rubeculoides* and is appreciably darker above than the females.

Measurements on p. 108.

1430 **Muscicapa macgrigoriae signata** (Horsfield) (Assam) Eastern Small Niltava 2: 260

19: 10 ♂♂ (2 by pl.) 6 ♀♀ 3 o? (1 juv.)

3 Singtam, Teesta Valley, 1 Pershoke, 1 Koalijhora, 1 Sikkim; 1 Bhutan Duars, 1 Honka, West, 1 Shamgong. 1 Tama, Central, 4 Deothang, Eastern Bhutan; 2 Margherita, 1 Sadiya, Upper Assam; 2 Laisong, N. Cachar.

Of six fairly recent males from Bhutan some show darker and others paler both above and below.

The original description applied to a female only and no attempt was made to compare it with the nominate form with which Stuart Baker synonymised it without comment.

♀ No. 4264 collected by Dr. H. N. Coltart at Margherita Assam on 28th November 1901, the oldest female specimen in the collection is more rufous, both above and below, than any of the others, the rufous of the tail extending over the back and head.

Measurements on p. 108.

1431 **Muscicapa sundara whistleri** (Ticehurst) (Murree) Western Rufousbellied Niltava 2 : 259

11: 6 ♂♂ (1 juv.) 4 ♀♀ 1 o? (juv.)

5 Koti State, 3 Simla; 1 Dhanaulti, Mussoorie, 1 Ranibagh. 1 Mornaula. Kumaon. Naini Tal Dist., U.P.

This form is said to differ from the nominate by the paler underparts of the male and the paler under and upperparts of the female.

It also differs from *sundara* by the smallness of the bill which appears more noticeable than is suggested by the actual measurements.

♂ No. 7246 from Mornaula, Kumaon, (5th Oct. 1934) has the underparts as deeply coloured as *sundara* but the bill is smaller, and in keeping with ♀ No. 16950 from the same area.

Measurements on p. 108.

1432 **Muscicapa sundara sundara** (Hodgson) (Nepal) Eastern Rufousbellied Niltava 2: 259 (part)

30: 11 ♂♂ (2 by pl.) 17 ♀♀ 2 o?

1 *Shema Chembo, S. Tibet;* 2 Moraghat forest, Duars, Jalpaiguri dt.; 2 Jorepothi, 1 below Sokipokv, Darjeeling; 1 Singtam, Teesta Valley, 1 Rangpo, 1 Namring, 1 Martam, Rongni Valley, 1 Sikkim; 1 Gedu, 1 Honka, 1 nr. Phuntsholing, West, 1 Shamgong, Central Bhutan; 1 Bhutan Duars, 5 Margherita, Assam; 2 Tirap Div., Arunachal Pradesh; 1 Kangpokpi, Manipur; 1 *Gora,* 1 *Hai Bum, Chindwin;* 1 *Pumsin,* 1 *Mt. Victoria,* 1 *Dimla* (?) *Burma,* 1 no data.

Individual females of both races show a varyingly pale forehead made largely by the pale or buff bases of the feathers.

Females of the nominate form also show darker underparts than in *whistleri* but there is considerable variation in the depth of grey and the more recently collected skins are darker both above and below. It is possible that representative series from different places may establish differences not yet appreciated. See other remarks under 1431.

Measurements on p. 108.

1433 **Muscicapa vivida oatesi** (Salvadori) (Muleyit) Rufousbellied Blue Flycatcher 2: 226

nil.

1434 **Muscicapa concreta cyanea** (Hume) (Muleyit) Whitetailed Blue Flycatcher 2: 215

7: 2 ♂♂ 5 ♀♀

6 Margherita, Assam; 1 *Hai Bum, Chindwin Exp.*

The two males collected in 1902 show no blue on the underparts, this presumably having become grey. One ♀ 3984 from Margherita has one blue feather on the forehead.

Measurements on p. 108.

1435 **Muscicapa pallipes** Jerdon (Coonoor Ghat) Whitebellied Blue Flycatcher 2: 228

18: 11 ♂♂ (1 by plumage) 7 ♀♀

1 Bhimashankar, Poona, 2 Mahabaleshwar, Satara, Maharashtra; 4 Molem, Goa; 1 Kodra, 1 Bilimani, 1 Naiti Savas, N. Kanara; 1 Bababudan Hills; 1 Mercara, Coorg, Karnataka; 1 Cherambadi, Gudalur, Nilgiris; 1 Santhanpara, Cardamon Hills; 1 Manalur, Palnis; 1 Thekady, Periyar Lake, 1 Murchiston, Ponmudi, S. Travancore; 1 no data.

♀ 23580 from Mahableshwar shows an exceptionally hooked bill.

Measurements on p. 108.

1436 **Muscicapa poliogenys poliogenys** (Brooks) (Salbari, Sikkim Terai) Western Brooks's Flycatcher 2 : 247 (part)

3: 1 ♂ 1 ♀ (juv.) 1 o?

1 Sarun, 1 Jalpaiguri, Bengal; 1 Shillong.

We have no specimens to substantiate the statement that two populations of this subspecies are separated by *cachariensis* and the identity of this juvenile is based entirely on the distribution as in IND. HANDBOOK 7 p. 186/7.

See remarks under 1438.

Measurements on p. 109.

1437 **Muscicapa poliogenys cachariensis** (Madarasz) (Dhilkusha, Cachar) Eastern Brooks's Flycatcher 2 : 247 (part)

5: 2 ♂♂ 3 ♀♀

1 Dibrugarh, 3 Margherita; 1 no data.

These are distinctly more rufous than nominate *poliogenys* both above and below. The

bills are slightly larger than in the other races.
Measurements on p. 109.

1438 **Muscicapa poliogenys vernayi** (Whistler) (Sankrametta, Vizagapatam dist., Eastern Ghats) Peninsular Brooks's Flycatcher

22: 8 ♂♂ 11 ♀♀ 3 o?

3 Anantgiri, 5 Sankrametta, 1 R. V. Nagar, Vizagapatnam, A.P.; 7 Gurguria, 2 Chahala, 1 Upper Barakamra, Simlipal Hills, 2 Badrama, Bamra, 1 Berbera, Puri dt., Orissa.

The blue on the upperparts in 4 ♂♂ 1 ♀ 2 o? is very distinctive but in the absence of a suitable series of nominate *poliogenys* it is impossible to be sure if all those without blue are of this race and not immigrants.

Measurements on p. 109.

1439 **Muscicapa unicolor unicolor** (Blyth) (Darjeeling) Pale Blue Flycatcher 2: 230

7: 6 ♂♂ (1 by pl.) 1 ♀ (by pl.)

1 Shamgong, 2 Tama, Central Bhutan; 1 Teju, Lohit Valley, 3 Margherita, Assam.

Only one of the series is olive-brown with no blue and though unsexed is put down as a female.

Measurements on p. 109.

1440 **Muscicapa rubeculoides rubeculoides** (Vigors) (Darjeeling) Bluethroated Flycatcher 2: 231

33: 18 ♂♂ (1 juv., 2 mm.) 12 ♀♀ (1 juv.) 3 o? (1 juv.)

1 Shogi, Kathlighat, 3 Besantpur, Bhajji State, 1 Solon, Bhagat State, 1 Goma-ki-hatti, Dharni State, 1 Khill, Patiala State, 1 Almora, 1 Kumaon, N. W. Himalayas; 1 New Delhi; 2 Goa; 1 N. Kanara, 1 Mercara, Coorg, Karnataka; 3 Thattakad, N. Travancore; 3 Point Calimere, Tanjore dt., T. N.; 1 Nallamalai, S. Kurnool, 1 Upper Sileru, Visakhapatnam, A. P.; 1 Baramba, 1 Orissa; 1 Baghowni, 1 Madhubani, Tirhut, Bihar; 1 Tama, 2 Mangdechu, C. Bhutan; 1 Dibrugarh, 2 Shillong, Assam; 1 Hungrum, N. Cachar.

The specimen from New Delhi ♂? No. 23771 obtained by A. J. Gaston on 21.10.1971 extended the range further westward than accepted in INDIAN HANDBOOK.

Measurements on p. 109.

EL. **Muscicapa rubeculoides dialilaema** (Salvadori) (Taho Plateau, N. Tenasserim) 2: 233

11: 5 ♂♂ (1 imm.) 3 ♀♀ (1 juv.) 3 o? (1 juv.)

1 *Kani, Lower Chindwin,* 1 *Pakokku;* 2 *N. Shan States;* 1 *Maymyo,* 1 *Mt. Victoria;* 1 *Mindon Yoma,* 1 *Leindon,* 1 *Khayauk Chaung, Thayetmyo;* 1 *Ngaphaw, Prome;* 1 *Inbin, Henzada, Burma.*

The differentiating character is said to be the rufous of the breast encroaching triangularly upon the blue of the chin, but this is not an infallible character being absent in No. 4044 from Mindon Yoma, Thayetmyo (5 Feb. 1930) and present in several from Indian limits, e.g. No. 4060 Kumaon (11 May 1902), No. 16809 Dharni State 5000', N. W. Himalayas (11 Sept. 1921), No. 23280 Pt. Calimere (12th Oct. 1969), No. 24130 Valvoi, Goa (10th Oct. 1972), No. 4054 Baghowni, Bihar (26 Nov. 1902); though not accepted, some of them may be migrants of this form. *Rogersi* described by Kinnear & Robinson from the Arakan Yomas is also difficult to identify, and I am for the moment leaving all the Burmese birds under the present form. Sp. 4044 from Thayetmyo mentioned above is marked *dialilaema* by Ticehurst as also two others from Inbin, Henzada and Ngaphaw, Prome dist. When dealing with the birds from Southern Arakan (JBNHS 36, p. 926) Ticehurst named two other birds from Thayetmyo (first year ♂ No. 4047, 7th Jan. 1930) and ♀ No. 4050 (12 Jan. 1930) as nominate *rubeculoides*, but both have pale yellowish rufous breasts which are quite different from any of the others either under 1440 or *dialilaema* and agree more closely with the description of *rogersi*. Smythies in BIRDS OF BURMA (1953) p. 582 says a revi-

sion is required and this is still awaited.

Measurements on p. 109.

1441 **Muscicapa banyumas magnirostris** (Blyth) (Darjeeling) Largebilled Blue Flycatcher 2: 236

nil.

1442 **Muscicapa tickelliae tickelliae** (Blyth) (Central India = Borabhum) Tickell's Red-breasted Blue Flycatcher 2 : 234

55: 36 ♂♂ (6 juv.. 1 with spotted head) 13 ♀♀ 6 o? (1 juv.)

1 Chanderi, Gwalior State; 1 Dalkania, Amreli dt., Kathiawar, 1 Cambay City, 1 Malegaon, 1 Pandura, Surat Dangs, Gujarat; 1 Sanchi, Bhopal State; 1 Choral, Indore State; 1 Gujni, 1 Mandu, Dhar State; 1 Paryat, Jubbalpore; 1 Madhmeshwar, Nasik, 1 Matheran, 1 Trombay Island, Bombay, 2 Poona, 2 Satara, 1 Ratnagiri, 1 Sawantwadi, Maharashtra; 3 Molem, 1 Valpoi, Goa; 1 Karwar, 1 Potoli, 1 Mokkigodda, 1 Kodra, 1 Alanki, 3 N. Kanara; 2 Murgimatta, Sagar, Mysore; 1 Begur, Manantoddy, 1 Chand Kunnu, Nilambur Valley, 1 Rajampara, 1 Maraiyur, S. Travancore; 1 Gudalur, 1 Ootacamund, Nilgiris; 1 Mudumalai, 1 Perumalmalai Coffee Estate Palnis; 2 Kurumbapatti; 1 Chitteri Range, Salem dt., 1 Shevaroy Hills; 1 Lamasinghi, Vizagapatnam, A.P.; 1 Badrama, Bamra, Orissa; 1 Antagarh, Bastar, 1 Lohatter, 2 Bhanuprattapur, Kanker, 1 Sonwani, Balaghat; 1 Pilibhit Terai, 1 Bahraich, U.P.; 1 Kausarden (?).

There is some variation in the intensity of the blue of the upperparts, partly at least, due to fading; on the whole the females are definitely paler.

Juvenile ♂ No. 4091 dated 29 August 1940 from Choral, Indore State, has a brown head spotted/streaked with buff. The wing-coverts are similarly marked. The blue of the upperparts is similar to that of 6 juvenile males [November, December (2), January, March, April] which are similar to the females, both in plumage and size. Among the unsexed birds No. 4096 from Mandu, Dhar State (9th Sept., 1938) is also very slightly streaked on the head and wingcoverts.

Measurements on p. 109.

1443 **Muscicapa tickelliae jerdoni** (Holdsworth) (few miles from Colombo, Ceylon) Ceylon Tickell's Flycatcher 2: 236

nil.

1444 **Muscicapa sordida** (Walden) (Ceylon) Dusky Blue Flycatcher 2: 241

1 ♂ Hakgalla, Ceylon.

Measurements on p. 110.

1445 **Muscicapa thalassina thalassina** (Swainson) (India) Verditer Flycatcher 2: 239

58: 33 ♂♂ (1 spotted juv.) 17 ♀♀ 8 o? (3 juv.)

1 Balaish, Badrawan, Kishtwar; 9 Simla, 1 Koti State, 2 Mussoorie, 1 Yoshinath, Garhwal, 3 Almora, 1 Jaunsar, Kumaon, 1 Ramgarh, Nainital, N. W. Himalayas, 1 Meerut, U.P.; 1 Vaghijipur, Mehsana dt., 1 Cambay City, Gujarat, 1 Chikalda, Berar, 1 Geedum, 1 Amraoti, Bastar, C. P., 1 Sawantwadi, Maharashtra; 1 Molem, 1 Valpoi, Goa; 1 Karwar, N. Kanara; 1 Mercara, Coorg, Karnataka; 1 Wynaad, S.I.; 1 Nallamalai, S. Kurnool, 1 Sankrametta, Vizagapatnam, Andhra Pradesh, 1 Badrama, Bamra, 1 Keonjhargarh, 1 Gurguria, 1 Upper Barakamra, Simlipal Hills, 1 Orissa; 1 Hathiban, Nepal; 1 Longview T. E., 1 Darjeeling; 2 Gedu, West, 1 Tama, 2 Batase, Central, 2 Rongtong, 1 Deothang, 1 Tashigong, East Bhutan; 1 Abor Country, Mishmi Hills, 1 Margherita, 1 Shillong, Assam, 1 *N' Krang, Upper Burma*, 1 *Taikmaw*, 1 *Prome dt.*, 1 *Henzada dt., Burma;* 1 no locality.

The males show variation in the extent of shiny blue feathers on the forehead, a few lacking them completely. Except for three or four the females show much less blue and can probably be separated from the males in the field. The juveniles are brown and spotted all over, these characters being retained lastly on the head.

Two males from Simla bearing collector (A. E. Jones) Nos. 61 and 62 have dark brown "faces" but in one the dark of the head is

covered by blue feathers and the darkness appears to be artificially acquired.

Measurements on p. 110.

1446 **Muscicapa albicaudata** Jerdon (Nilgiris) Nilgiri Verditer Flycatcher 2: 242

24: 15 ♂♂ 8 ♀♀ 1 o? (juv.)

4 Honnametti Estate, 2 Edbathi, Biligirirangan Hills, Coorg, Karnataka; 2 Naduvattam, 2 Coonoor, 1 Mullumund, 1 Avalanche, Nilgiris; 1 Kodai, 2 Kodaikanal, 6 Shembagnur, 1 Palnis; 1 Anaimudi Peak, 1 Santhanpara, Travancore.

The key in IND. HANDBOOK (7, p. 139) separates the males by the white in the tail being restricted to the basal *half* and the females with the whole plumage tinged with blue. The white in the male tail hardly extends over a third of the basal part, while the bluish tinge in the females is barely visible. Stuart Baker (2, p. 242) referred only to the upper tail-coverts as blue. The key to the many species of *Muscicapa* is however a very difficult piece of work well carried out.

Measurements on p. 110.

EL. **Muscicapa narcissima** subsp.

3: 2 ♂♂ 1 ♀

Purchased alive in Peking (May 1901) and later marked *Muscicapa narcissima xanthopygia* Hay.

Measurements on p. 110.

1447 **Muscicapella hodgsoni hodgsoni** (Moore) (Nepal) Pygmy Blue Flycatcher 2: 237

1 ♂ Rangpo. 2000′ Sikkim.

I measure the bill 8 mm from feathers as against 6 mm in Stuart Baker and "*c*. 11 from skull" in INDIAN HANDBOOK.

Measurements on p. 110.

1448 **Culicicapa ceylonensis calochrysea** Oberholser (Quaymoo Choung = left bank of Thaungyin R., latitude 17° 15′ N. Amherst dist., Tenasserim) Northern Greyheaded Flycatcher 2: 254

63: 32 ♂♂ (2 juv.) 13 ♀♀ 18 o?

10 Simla, 1 Koti State, 1 Dhanaulti, Mussoorie, 2 Garhwal, 3 Almora, N. W. Himalayas; 2 Meerut, U.P.; 1 Sanchi, Bhopal State, 1 Jubbulpore, 1 Bori Forest, Hoshangabad, M.P.; 1 Kutch; 1 Hathidara, Palanpur State, 1 Cambay City, Gujarat; 1 Chikalda, Berar, 1 Antagarh, 1 Choti Dongar, 1 Bastar dt., C. P.; 1 Sankrametta, Vizagapatnam Hills, A.P.; 2 Koira, Bonai, 2 Badrama, Bamra: 1 Chahala, Simlipal Hills, 1 Orissa; 1 Baghowni, 1 Darbhanga, Bihar; 1 Sarsawa, in Saharanpur, U.P.; 1 Tribani, 2 Bans Bahari, Nepal; 1 Kewzing, 1 Rinchinpong, West, 1 Rangpo, Sikkim; 1 Tama, 1 Batase, Central, 1 Wamrong, 1 Rongtong, 1 Gomchu, E. Bhutan; 5 Dibrugarh, Assam; 1 Miao, Tirap div., Arunachal Pradesh; 1 *Loukin*, 1 *Loha Kaw, Chindwin Expdn.*, 1 *N'Krang, U. Burma*, 2 *Prome dt.*, 1 *Lindon Yoma, Thayetmyo dt., Burma*; 1 *Puntha Bat Watershed* 5000′. *China* (?).

The juveniles do not differ from the adults in colour. Ticehurst (JBNHS 31: 494) went so far as to say they were for this reason, not flycatchers.

The rictal bristles are not as long or as dense as illustrated in Stuart Baker's FAUNA and reproduced in INDIAN HANDBOOK 7, p. 202.

The last work (p. 203) suggests its breeding in the Central Satpuras above 900 m (Betul and Pachmari) "but nesting not substantiated, and almost certainly the Eastern Ghats (Visakhapatnam district) but summer data entirely wanting". The Eastern Ghats Survey (JBNHS 36, p. 88) obtained specimens in March and I noted several at Lamasinghi during the last week in May (JBNHS 45, p. 337). The last is presumably the "almost certain evidence" for its breeding but is not accepted as "summer data". Later, Trevor Price (JBNHS 76, p. 415) obtained a recently fledged juvenile on 13th July, leaving no doubt regarding its breeding in the area.

* Specimen No. 4218 from Puntha Bat

Watershed 5000′, was collected by Major H. J. Walton on 28 Dec. 1900. No other data is available but as other specimens were obtained by him on 1 Sept. 1900 and 7 June 1901 at Peking, China, Puntha Bat may be accepted as somewhere in China. The specimen differs from the others in having a 55 mm tail which is 94.8% of the 58 mm wing. In none of the other specimens does this proportion exceed 92% (as in one from Shillong) being usually under 90%.

Measurements on p. 110.

1449 **Culicicapa ceylonensis ceylonensis** (Swainson) (Ceylon) Southern Greyheaded Flycatcher 2: 254

9: 3 ♂♂ 3 ♀♀ 3 o?

1 Longwood Shola, Kotagiri, 1 Coonoor, Nilgiris; 3 Shembagnur, 1 Kodaidinal, Palnis; 1 Maraiyur, 2 Travancore.

We have no topotypical material from Ceylon but the birds from Southern India are much darker both above and below than those from further north and can presumably be accepted as of the nominate race.

Measurements on p. 110.

1450 **Rhipidura hypoxantha** Blyth (Darjeeling) Yellowbellied Fantail Flycatcher 2: 275

28: 17 ♂♂ 5 ♀♀ 6 o?

1 Simla, 1 Mashobra, Koti State, 1 Kalka, Bhagat State, 1 Bamra, 1 Khulasa, Garhwal, N. W. Himalayas; 1 Labru, Ambala, Punjab; 1 Godaveri, Nepal; 1 *Sulang Ba, S. Tibet*, 1 Martam, Rongni Valley, 1 Darjeeling Terai; 1 Singtam, Teesta Valley, 1 Singhik, Sikkim; 1 Bhutan Duars, 1 Batase, 1 Shamgong, 1 Bumthang, Central, 1 Deothang, East Bhutan; 1 N. Lakhimpur, 1 Dibrugarh, 2 Tezu, Lohit Valley, 1 Sadiya, Upper Assam, 1 Bipani, Dibong Valley, Mishmi Valley, Assam; 1 Tipi, 1 Miao, Tirap Div., Arunachal Pradesh; 2 *Mt. Victoria, Burma*, 1 *Punthabat Water Shed, China.*

The upperparts of both sexes are said to be dark greyish olive and the females to differ only in having the eye-band blackish olive-brown contra black in the male. Some of the specimen of both sexes have brownish upperparts with or without eye stripes of the same colour, but most of the specimens are in very poor conditions (as in several other species of flycatchers) and it is not possible to link these differences with size, age, date or place of origin.

None of them can be said to be juvenile.

Measurements on p. 110.

1451 **Rhipidura aureola aureola** Lesson (Bengal) Northern Whitebrowed Fantail Flycatcher 2: 277

25: 12 ♂♂ 8 ♀♀ 5 o?

2 Bhung, Bahawalpur; 2 Shikahpur, Jullunder, 2 Ambala, Punjab; 2 Meerut; 1 Delhi; 1 Gwalior; 1 Cambay City environs, 1 Bodeli, Baroda, Gujarat; 1 Sanchi, Bhopal State, 1 Jubbulpore, 1 Golapalli, Bastar, 2 Bhanuprattapur, Kanker C.P.; 1 Barkot, Bamra, 1 Koira, Bonai, 2 Keonjhargarh, 1 Chahala, Simlipal Hills, Orissa; 1 Kalianpur, 1 Cawnpore, U.P.; 1 no locality.

The above have been separated largely on the white of the outer rectrices reaching the white of the undertail-coverts, but as indicated by Whistler in the Eastern Ghats report it is not easy to separate all the specimens, because of the poor condition of most of the skins. Six of them (3 ♂♂ 1 ♀ 2 o?) from Bodeli, Baroda; Keonjhargarh, Simlipal Hills, Orissa and Golapalli, Bastar, have two pairs of black feathers in the middle of the tail, while another eight (2 Shikahpur, Jullunder, 1 Bhung, Bahawalpur, 2 Cawnpore, 2 Meerut, 1 Delhi) have brown heads not very different from the single specimen from Burma which is really in tatters. This bird from Burma has 2 black central rectrices. We have no specimen in juvenile plumage.

Measurements on p. 111.

1452 **Rhipidura aureola compressirostris** (Blyth) (Ceylon) Southern Whitebrowed Fantail Flycatcher 2: 277, 279

4: 1 ♂ 3 ♀♀

1 Kottayam, 1 Golf Links, Trivandrum, Kerala; 1 Seshachalum Hills, S. Cuddapah; 1 Sankrametta, Vizagapatnam.

No topotypes were available for comparison and the British Museum was good enough to send in 2 from Ceylon and 4 from S. India identified as of this race by Whistler when working out the Eastern Ghats and Travancore collections. The character of the two central tail feathers being black is shared with others from the north (*supra*) and the compressed (wider?) bill suggested by Blyth's original description is not visible.

Measurements on p. 111.

1453 **Rhipidura aureola burmanica** (Hume) (Thoungyeen Valley, Tenasserim) Eastern Whitebrowed Fantail Flycatcher 2: 278

1 ♂ *Kerenuth, Burma.*

Hume's original description was based on a carbolised specimen in which the tail was in moult. The discriminating characters are very confusing and I have already referred to specimens under nominate *aureola* having heads as brown as the back, the character on which this is separated from *aureola* in the key in IND. HANDBOOK (7, p. 207).

Measurements on p. 111.

1454 **Rhipidura albicollis canescens** (Koelz) (Bhadwar, Punjab) Western Whitethroated Fantail Flycatcher 2: 279 (part)

6: 4 ♂♂ 2 ♀♀

1 Kharda Ghat, Patiala State, 1 Goma-ki-hatti, Dharni State, 1 Keonthal State, 1 Simla; 1 Moundkhal, Garhwal, 1 Kumaon, N. W. Himalayas.

Slightly paler than other Himalayan birds from the east. The dark portion of the rectrices fades into the paler tip which is not sharply demarcated white by a straight line as in *albicollis.*

Measurements on p. 111.

1455 **Rhipidura albicollis albicollis** (Vieillot) (Bengal) Eastern Whitethroated Fantail Flycatcher 2: 279 (part)

2: 1 ♀ 1 o?

1 Kumbhia, Nepal; 1 Singtam, Teesta Valley, Sikkim.

This is darker than *canescens* but in the specimens obtained over a long period the different grades of fading do not permit separation from 1456, (*stanleyi*), and the grouping has been done on the distributional limits in IND. HANDBOOK.

Measurements on pp. 111/2.

1456 **Rhipidura albicollis stanleyi** Baker (Abor Hills) NEFA Whitethroated Fantail Flycatcher 2: 279 (part)

11: 4 ♂♂ 4 ♀♀ 3 o?

2 Dibrugarh, 1 Dening, Lohit Valley, 1 Mishmi Hills, 1 Margherita, 1 Bahra Pari, Shillong, Assam; 1 Firm Base, Tirap Div., Arunachal Pradesh; 1 Kohima, Naga Hills, 1 Laisong, N. Cachar, 1 *Mogoki,* 1 *N'Krang, Upper Burma.*

The last specimen No. 26324 from Firm Base, Arunachal Pradesh (Dec. 1981) is sooty black with ashy underparts cf. various shades of brown in the others going back to 1900. Without fresh material it is not possible to express any opinion.

Measurements on pp. 111/2.

1457 **Rhipidura albicollis orissae** Ripley (Toda, Bonai, Orissa) Orissa Whitethroated Fantail Flycatcher 2: 279 (part)

5: 4 ♂♂ 1 ♀

1 Rosul, 1 Toda, 1 Koira, Bonai, 1 Keonjhargarh, 1 Upper Barakhamra, Simlipal Hills, Orissa.

The underparts are slightly paler than in *canescens* but "the patch of buff in centre of

belly" which was the main difference for its separation in 1955, is not now visible.

Measurements on pp. 111/2.

1458 **Rhipidura albicollis albogularis** (Lesson) (Salem dist., Madras) Whitespotted Fantail Flycatcher 2: 282 (part)

15: 7 ♂♂ 7 ♀♀ (1 juv.) 1 o?

1 Cambay City environs. 1 Vaghjipur. Mehsana dt., 1 Ajwa, Baroda, dt.; 1 Jubbulpore, 1 Chikalda, Berar; 1 Murbad Rd., Kalyan. 2 Trombay Island. Bombay; 1 Poona. Deccan, 1 Rajapur. Ratnagiri, 1 S. Konkan; 1 Karwar. N. Kanara, 1 Kurumbapatti. Salem dt., 2 Nallamalai. S. Kurnool.

The spots on the breast appear less distinct in the cabinet specimens than in the live birds in the field.

Measurements on pp. 111/2.

1459 **Rhipidura albicollis vernayi** (Whistler) (Jeypore Agency) Dandkaranya Whitespotted Fantail Flycatcher 2:282 (part)

7: 6 ♂♂ 1 ♀

4 Bailadila, Bastar dt., C. P.; 1 Sankrametta. 2 Anantgiri. Vizagapatnam. Andhra Pradesh.

This race with a broad pectoral band, the almost complete absence of spots on the breast and the rufous on the under belly is distinctive.

Measurements on pp. 111/2.

1460 **Terpsiphone paradisi leucogaster** (Swainson) (Simla) West Himalayan Paradise Flycatcher 2: 268

26: 17 ♂♂ (8 white) 9 ♀♀

5 Chitral; 1 Kutyara. 1 Mogul Maidan, Kishtwar; 1 Dharamsala. Punjab; 1 Keonthal State; 8 Simla. 1 Sairi. Patiala State. 1 Almora. N. W. Himalayas; 1 Guna. Gwalior State; 1 Rapur. Kutch. 1 Juna. Rajpipla. Gujarat; 1 Molem. Goa; 1 Settihalli. Shimoga dt.. Mysore; 2 Cherambadi. Gudalur. Nilgiris.

The rufous males and females can be distinguished by their paler upperparts and the former by the white of the underparts being separated from the black of the chin in a straight line. The white males are from their accepted breeding grounds. Vaurie (1959 p. 325) states that in addition to the paler upperparts this has the outer web of the blackish primaries white instead of reddish, but this is not consistent and may only be preliminary to acquiring an all-white plumage.

Measurements on p. 112.

1461 **Terpsiphone paradisi paradisi** (Linnaeus) (Chandernagor) Peninsular Indian Paradise Flycatcher 2:264 (part)

29: 18 ♂♂ (7 white) 9 ♀♀ 2 o?

1 Bijwar, Vindhyas. Indore State; 1 Songadh. Navsari. Gujarat; 1 Rajora. C. P.; 1 Chikalda, Berar, 2 Khandala, 1 Vengurla. Ratnagiri.' Maharashtra; 2 Karwar, North Kanara, 1 Antarsante, Mysore; 1 Thattakad. North. 1 Kumili, 1 Tenmalai, 1 Edanad, Travancore; 1 Manalur, Palnis, 1 Kalutura, Ceylon; 2 Point Calimere, Tanjore dt., 3 Kurumbapatti, Salem dt., Tamil Nadu; 1 Palkonda Hills, 1 Seshachalam Hills, S. Cuddapah. 1 Sankrametta, Vizagapatnam, A.P.; 4 Baghowni, Dharbhanga. Bihar; 1 Cawnpore, U.P.

Except for white male No. 4261 collected on 16th June 1903 at Baghowni, Darbhanga dist., Bihar, the 6 other white birds were obtained between 26th Sept. (Ceylon) and 5 April (Sankrametta, Vizagapatnam dist.) and may well be *leucogaster*.

The 6 from the Eastern Ghats [4 ♂♂ (1 white) 2 ♀♀] from Kurumbapatti, Salem dist., to Sankrametta, Vizagapatnam, have their bills distinctly larger from 21.5 × 7.8 at nostrils to 23.7 × 9.2 compared to 4 ♂♂ (1 white 3 rufous) from Darbhanga, Bihar which are 17.7 × 8.4, 20.5 × 8.2, 19.3 × 7.3, 18.7 × 7.6.

The last are the nearest to the type locality (Chandernagore) available to us, and the difference in the size of the bill is very striking. It is quite possible that a series from the type locality or any other place now accepted as

in the breeding range of nominate *paradisi* would permit recognition of a new race.

Measurements on pp. 112/3.

1462 **Terpsiphone paradisi ceylonensis** (Zarudny & Harms) (Ceylon) Ceylon Paradise Flycatcher 2: 264 (part)

1 ♀ Ceylon.

This race is separated from the others by the absence of a fully white adult male phase. The specimen was obtained in June, during the breeding season and would presumably be of this race, while a white male obtained at Kalutura on 31 Oct. 1920 is to be accepted as a migrant *paradisi.* In the single female the underparts are also a purer white as in *leucogaster* rather than in *paradisi.*

Measurements on pp. 112/3.

1463 **Terpsiphone paradisi saturatior** (Salomonsen) (Buxa Duars, Bhutan) East Himalayan Paradise Flycatcher 2: 267

6: 5 ♂♂ (2* white, 1 red juv.) 1 ♀

1 Kurseong, Darjeeling, 1* Lakhimpur, 2 Dibrugarh, 1 Haflong, N. Cachar, 1* *Kani, Lower Chindwin, Burma.*

The birds in red plumage have no prolonged crest and in the white male it is also shorter than in *paradisi* and *leucogaster.* In the white male the black shafts and edges to the tail feathers are wider and more prominent.

The white male from Kani, the type locality of *burmae*, has a shorter crest and is more heavily streaked on the upperparts than others from the same place and is possibly a migrant of this form. The white male obtained in the Andamans had its tail examined by Hume who thought it was *affinis.* This may also have been a *saturatior* which is presumably a migrant form.

Measurements on pp. 112/3.

1464 **Terpsiphone paradisi nicobarica** Oates (Great Nicobar) Nicobar Pradise Flycatcher 2: 269

5: 3 ♂♂ 2 ♀♀

4 Camorta, 1 Trinkut, Central Nicobars.

When examining the Nicobar collection (JBNHS 64, p. 183) I drew attention to 8 ♂♂ from Central Nicobars being chestnut and four from Great Nicobar white and restricted the type locality to Great Nicobar.

The chestnut birds from Central Nicobars are very close to *saturatior* but have a slight wash on the upper surface and the males presumably like Ceylon birds, and unlike *saturatior*, do not acquire a white phase.

Measurements on pp. 112/3.

EL. **Terpsiphone paradisi burmae** (Salomonsen) (Kani, Lower Chindwin, Burma) Burmese Paradise Flycatcher

2 white ♂♂ *Kani, Lower Chindwin, Burma.*

These differ from *saturatior* in having a larger crest and less streaking on the upperparts.

Measurements on pp. 112/3.

EL. **Terpsiphone paradisi affinis** (Blyth) (Malay Peninsula and Tenasserim)

2: 1 white ♂ 1 ♀ (both by plumage)

2 *Malacca.*

The male is heavily streaked with black on the upperparts and the female is a much darker chestnut above with no olive wash as in *nicobarica.* The white ♂ (by plumage) No. 4310 was marked *nicobarica* by Sálim Ali many years ago.

Measurements on pp. 112/3.

EL. **Terpsiphone paradisi incei** (Gould) Chinese Paradise Flycatcher

3 ♂♂ *Temple of Heaven, Peking, China.*

2 with long tails are dark chestnut above, have a black chin followed by a grey upper breast and whitish below. No. 4306 * marked ♂ has a short tail, with paler chestnut on the upperparts. The head is duller and the crest

shorter, being prominent in the others.

Measurements on p. 112.

1465 **Monarcha azurea styani** (Hartlaub) (Harhow, Hainan) Indian Blacknaped Monarch Flycatcher 2: 271

66: details below.

In JBNHS 64, p. 185 I had referred to 14 females from peninsular India being greyer above than 10 from Assam and Burma which appeared brown. Three more females from Goa and Kerala have been added to the collection and these are very distinctly greyer above as compared to the older skins. It is quite probable that with fresh series from different parts of India and Burma it should be possible to accept Stuart Baker's *sykesi* which was to replace Sykes's *Muscicapa caeruleophala* from Dukhun. I am for the moment grouping them separately under *styani*.

(a) 15: 5 ♂♂ (1 in juv. plumage) 8 ♀♀ 2 o?

1 Abor country, Mishmi Hills, 2 Assam; 1 *Kani, Lower Chindwin*, 1 *Kamaing*, 1 *Manku, North Shan States*, 2 *Jobni*, 1 *Thayetmyo dt.*; 1 *Sandoway dist.*; 1 *Nyaunggyo*, 1 *Rankuang, Prome dt.*, 1 *Kyibin*, 1 *Panktaing, Henzada dt.*; 1 *Burma*.

(b) 51: 27 ♂♂ (1 by pl. and 6 juv.) 21 ♀♀ 3 o?

1 Dwarka, Okhamandal, Kathiawar, 1 Chikli, 1 Sarwar, Surat Dangs, 1 Songadh, Navasari dt., Gujarat; 2 Gondia, C. P.; 1 Kolkaz, Melghat, Berar, 1 Borivli, 1 Mulund Hills, Salsette Island, 1 Kihim, Alibag, Kolaba dt., 1 Ratnagiri, 1 Savantwadi, Maharashtra; 1 Molem, 2 Valpoi, Goa; 2 Karwar, 1 Kumta, N. Kanara, Karnataka; 1 Kottamalai, Gudalur, Nilgiris, 1 Begur, Manantoddy, 1 Periyar Lake environs; 1 Maraiyur, 3 Manalur, Palnis, 2 Kurumbapatti, Salem dt.; 2 Nallamalai Range, S. Kurnool; 1 Borgampad, 1 Nelipaka, Hyderabad; 1 Anantgiri, Vizagapatnam, A. P., 1 Lahatter Res. Forest, 2 Bhanupratappur, Kanker, 2 Chota Dongar, 1 Bailadila, Bastar, M.P.; 2 Badrama, Bamra, 1 Koira, Bonai, 1 Tikerpada, Angul dt., 1 Rosul, Hindol, Orissa; 2 Madhubani, 3 Baghowni, Darbhanga, Bihar; 1 Tama, 1 Gaylegphug, C. Bhutan, 1 no data.

Males of the year (14 Oct-24 April) are like the females but can be distinguished by the horny *contra* black bills in the adults.

Measurements on p. 113.

1466 **Monarcha azurea ceylonensis** (Sharpe) (Cotta, Ceylon) Ceylon Blacknaped Blue Flycatcher 2: 272

2: 1 ♀ 1 o?

1 Labugama, 1 Ceylon.

The ♀ No. 4324 has the blue of the throat equivalent to that on the head, both brighter than in Indian birds. The unsexed bird No. 4325 is in poor condition and it is not possible to determine the colour of the head.

Measurements on p. 113.

1467 **Monarcha azurea tytleri** (Beavan) (Port Blair, Andamans) Andaman Blacknaped Blue Flycatcher 2: 273

9: 6 ♂♂ 2 ♀♀ 1 o?

1 Landfall Island, N. Andaman; 3 Long Island, 1 Bakultala, Middle Andamans; 1 Chirria Tapu, 1 Wrightmyo, 2 South Andamans.

Measurements on p. 113.

1468 **Monarcha azurea idiochroa** (Oberholser) (Car Nicobar) Car Nicobar Blacknaped Blue Flycatcher 2: 274

4: 2 ♂♂ 2 ♀♀

1 Perka, 3 Car Nicobar.

Measurements on p. 113.

1469 **Monarcha azurea nicobarica** (Bianchi) (Nancowry, Central Nicobar) Nicobar Blacknaped Blue Flycatcher 2 : 273

3: 1 ♂ 2 o? Trinkut, Central Nicobars.

5: 4 ♂♂ 1 ♀ Campbell Bay, Great Nicobars

When dealing with my first collection of Nicobar birds (1967, JBNHS 64, p. 184) I had referred to Great Nicobar birds being smaller than those from Central Nicobar, and the females being browner and less grey above. At that time I had 15 specimen in hand, and in the absence of any additional material, I am unable to say anything more.

The 13 males from the Andaman and Nicobar Islands do not include any definitely sexed immature male with blue head and brown upperparts, i.e. in female plumage.

Measurements on p. 113.

PACHYCEPHALINAE

1470 **Pachycephala grisola** (Blyth) (neighbourhood of Calcutta) Grey Thickhead or Mangrove Warbler 2: 484

8: 5 ♂♂ 3 o?

2 Landfall I., North Andamans; 1 Long Island; 2 Port Blair, 2 Chirria Tapu, 1 S. Sentinel I., S. Andaman.

The two most recent skins from Chirria Tapu (3rd & 5th Feb. 1980) have pale yellowish bills and the rufous edges to the secondaries indicate juveniles. All the birds sexed are males. I measure the tarsi smaller and the tails longer than in Baker's Fauna repeated in Ind. Handbook.

Measurements on p. 113.

1402 **Rhinomyias brunneata nicobarica**

	Wing	*Bill*	*Tarsus*	*Tail*
♀♀ (2)	76,77	15.5, 15.8	16.8, 17	55 (2)
	(IH ♀♀ 74-75	from skull 18-19	18	52-54)

1403/1404 & EL. **Muscicapa striata** subsp.

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂				
1403/1404 *sarudnyi* (9)	83-90 av. 86	13.2-15 av. 13.9	13.2-15 av. 14.4	59-66 av. 62
	(IH 82-92	from skull 14-18	14-16	60-65)
EL *striata* (2)	84, 86	12.5, 13.8	12.7, 13.5	56, 67
	(HBB 81-89	from skull 13-14	13.5-16	58-63)
♀♀				
1403/1404 *sarudnyi* (4)	81,84,86,87	12.2, 13.2, 13.5, 14	13.1. 13, 15. 15.5	56. 61, 62. 64
	(IH 82-92	from skull 14-18	15-16	59-65)
EL *striata* (1)	86	14	14.4	56
	(HBB 80-89	—	—	—)
o?				
1403/1404 *sarudnyi* (11)	83-89 av. 86.3	12-14 av. 13.0	13.4-16.2 av. 14.2	56-64 av. 60.3
El *striata* (1)	86	13.5	13.6	56

1405/1406 & EL **Muscicapa sibirica** subspp.

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (adults)				
1405 *gulmergi* (11)	70-77 av. 73.4	8.2-10 av. 9.3	10-12 av. 10.8	45-50 av. 46.2
	(IH measurements as in 1406)			
1406 *cacabata* (1)	75	8.7	—	47
	(IH 70-76	from skull 11-12	10-12	45-51)
EL *sibirica* (2)	75, 79	9.5, 9.7	—	50. —
♀♀ (adults)				
1405 *gulmergi* (2)	73 (2)	10.1. 10.2	11.4, 11.5	44, 46
	(IH 70-76	from skull 11-12	10-12	47-52)
EL *sibirica* (3)	77. 78. 80	9.8, —	9.5, —	45, 50, 51

1407 **Muscicapa latirostris**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (18)	68-74 av. 71	10.4-12.6 av. 11.2	10.6-14.3 av. 12.1	46-53 av. 49
	(IH 69-76	from skull 13-15	13-15	46-54)
♀♀ (16)	68-73 av. 70	10-11.9 av. 11	11-12.8 av. 11.1	44-50 av. 46.8
	(IH 66-73	from skull 12-15	13-14	46-51)
o? (11)	67-73 av. 70	10.7-12.4 av. 11.2	10.9-13.2 av. 12	45-51 av. 48.3

	Wing	Bill	Tarsus	Tail
♂♂ (6)	68-72 av. 70.3	11.9-13 av. 12.6	13.2-15.2 av. 13.7	46-51 av. 50
	(IH 72-75	from skull 16-17	13-14	49-56)
♀♀ (3)	70, 71 (2)	12.5, 13.2, 13.5	13.2, 13.7, 14.5	48, 50, 52
	(IH 67-76	from skull 16-17	13-14	48-55)
o? (4)	67, 71, 72 (2)	12, 12.6, 13.1, 13.5	12.2, 12.6, 13.5, 13.7	48, 51, 51, 52
1409 Muscicapa ruficauda				
♂♂ (5)	72-78 av. 75.8	10.6-12.4 av. 11.4	13.6-15.5 av. 14	53-59 av. 54.8
	(IH 73-77	from skull 14-16	c. 17	57-60)
♀♀ (6)	74-79 av. 76	11.4-13 1 av. 12.4	14-16.5 av. 15.2	53-59 av. 55.5
	(IH 75-77	from skull 14-16	c. 17	55-58)
o? (4)	72, 72, 78, 81	11.3, 12, 12.1, 12.6	13, 14.4, 14.6, 14.8	49, 53, 53, 55
1410 Muscicapa ferruginea				
o? (2)	70, 72	10.2, 11.2	9.5, 9.8	75, 76
	(IH ex Koelz ♂♀ 63-72	—	—	—)
1411/12 Muscicapa parva subspp.				
♂♂				
1411 *parva* (a) (5)	67-70 av. 69.4	9.5-10.8 av. 10.2	15-17.8 av. 16.3	50-53 av. 51.4
	(IH 64-72	from skull 12-14	17-18	47-54)
1412 *albicilla* (a) (10)	67-72 av. 69.5	8.3-10 av. 8.9	14.5-16.5 av. 15.3	45-52 av. 49
	(IH 66-72	from skull 13-14	c. 17	50-53)
1411 *parva* (b) (18)	64-72 av. 68	9.1-11.3 av. 10.3	13.2-17.5 av. 16	46-53 av. 50.5
1412 *albicilla* (b) (1)	70	8.7	15.8	49
1411 *parva* (c) ♂♂ in ♀♀ plumage (17)	64-70 av. 67.3	8.6-10.7 av. 9.8	13.7-17.7 av. 15.8	46-52 av. 49
1412 *albicilla* (c) ♂♂ in ♀♀ plumage (6)	65-71 av. 67.8	8.8-10 av. 9.5	14.3-17.5 av. 16.1	49-52 av. 49.6
♀♀				
1411 *parva* (18)	63-72 av. 67	8.2-10.6 av. 9.6	13.7-17.1 av. 15.6	45-53 av. 49
	(IH 64-71	from skull 12-13	c. 17	48-54)
1412 *albicilla* (10)	66-72 av. 67.9	8.1-10 av. 8.9	14-15.5 av. 14.9	44-52 av. 47.4
	(IH 67-71	from skull 13-14	c. 17	48-53)
1413 Muscicapa subrubra				
♂♂ (4)	68, 69, 70, 71	9.3, 9.4, 9.9, 10.8	14.5, 15.5, 16, 16.2	51, 52 (3)
	(IH 7 ♂♂ 65-70	from skull 12-13	18-19	49-54)
♀♀ (2)	67, 67	9.5, 11.7	15, 17.2	45, 49
	(IH 1 ♀ 67	13	18	50)
o? (1)	64	10.9	15.5	48)

1414 Muscicapa strophiata strophiata

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (21)	71-76 av. 73.7	9.4-11.4 av. 10.6	16.5-19.5 av. 17.8	52-60 av. 56
	(IH 69-80 mostly 72-75	from skull 12-14	19-22	53-63)
♀♀ (12)	67-74 av. 70.5	9.3-11.2 av. 9.9	16-19.5 av. 17.7	50-55 av. 53
	(IH 67-77	from skull 12-14	19-21	55-58)
o? (3)	73, 74. 76	10, 10.5, 11.2	16.5, 17.2, 17.9	56, 56, 57

1415/16 Muscicapa monileger subspp.

1415 *monileger* ♀ (1)	63	11	20.7	45
	(IH ♂♀ 60-65	*c.* 10	*c.* 23	45-50 Baker)
1416 *leucops* ♀♀ (3)	61, 61. 62	10.8, 11.2, 12.7	20.3, 20.6, 20.7	44, 45, 46
	(IH 1 ♀ 62	14	20	45 MD)

1417 Muscicapa hyperythra hyperythra

♂♂ (18)	58-64 av. 60.4	9.2-10.9 av. 10.2	16-18.2 av. 17	36-43 av. 39.6
	(IH 56-63	from skull 11.13	18-20	38-45)
♀♀ (8)	55-59 av. 57	8.6-10.7 av. 9.6	15.2-16.7 av. 16.1	36-41 av. 38
	(IH 56-60	from skull 11-13	18-19	37-41)

1418 Muscicapa hodgsonii

♂♂ (3)	71, 73, 74	8.6, 8.7, 9.5	13, 14.3, 15	55, 56, 56
	(IH ♂ 68-74	from skull *c.* 12	*c.* 16	56-58)
♀ (1)	68	9.3	15.5	52
	(IH ♀ 66-68	from skull *c.* 12	*c.* 16	50-54)
o? (2)	70(2)	9.9 (2)	15, 15.3	52, 54

1419/20 Muscicapa westermanni subspp.

♂♂				
1419 *collini* (2)	57, 57	10.5, 10.7	13.7, 15.5	40, 44
	(IH 53-61	from skull 12-14	14-16	38-47)
1420 *australorientis* (11)	57-60 av. 58.9	10-11.1 av. 10.3	13-15.9 av. 14.3	40-45 av. 42.2
	(IH measurements as in 1419)			
♀♀				
1420 *australorientis* (7)	54-59 av. 56.4	8.6-10	12.6-15.6 av. 13.4	37-49 av. 41.5
	(IH 53-60	from skull 12-13	14-16	40-43)

1421/22 **Muscicapa superciliaris** subspp.

	Wing	Bill	Tarsus	Tail
♂♂				
1421 *superciliaris* (20)	61-67 av. 63.2	10-12.3 av. 10.9	12.7-17.1 av. 14.3	42-47 av. 44.5
	(IH measurements as in 1422)			
1422 *aestigma* (1)	62	10	14.1	44
	(IH 60-66	from skull 12-14	15-17	42-48)
♀♀				
1421 *superciliaris* (9)	58-61 av. 60.2	10-12.2 av. 10.7	12.5-15.8 av. 14.4	38-44 av. 41.8
	(IH measurements as in 1422)			
1422 *aestigma* (2)	55, 55	9, 10.5	14.3, 17	40, —
	(IH 59-64	from skull 12-13	15-16	42-45)

1423/25 **Muscicapa leucomelanura** subspp.

	Wing	Bill	Tarsus	Tail
♂♂				
1423 *leucomelanura* (7)	58-61 av. 59.8	10.2-11.1 av. 10.6	15.5-18.5 av. 17	46-51 av. 48.7
	(IH 57-63	from skull *c.* 13	*c.* 18	49-56)
1424 *minuta* (4)	58-63 av. 61	9.5-11.3 av. 10.5	15.6-19.5 av. 18.3	48-52 av. 49.7
	(IH 59-64	from skull 12-13	19-20	47-54)
1425 *cerviniventris*	57	—	16.5	51
(1 ♂ by pl.)	(IH 55-59	from skull 11-12	—	46-51)
♀♀				
1423 *leucomelanura* (4)	56-58 av. 57.2	9.5-11.2 av. 10.1	15.5-17.4 av. 16.7	44-53 av. 49
	(IH 54-60	from skull c.13	*c.* 18	43-55)
1424 *minuta* (6)	55-60 av. 57.6	9.6-10.5 av. 10	17.2-18.5 av. 18	45-50 av. 47.6
	(IH 55-60	from skull 12-13	19-20	45-49)

1426 **Muscicapa sapphira**

	Wing	Bill	Tarsus	Tail
♂♂ (8)	59-65 av. 62.3	10-10.8 av. 10.3	14.2-16 av. 15	43-49 av. 45
	(IH 59-65	from skull 12-13	16-17	44-51)
♀♀ (2. 1 uncertain)	57, 60	9.7, —	13.5	41, 45
	(IH 57-61	from skull 12-13	16-17	40-44)
o? (1)	60	10.8	16.5	40

1427 **Muscicapa nigrorufa**

	Wing	Bill	Tarsus	Tail
♂♂ (13)	57-64 av. 61.3	10.3-12.2 av. 11.4	16.3-19.7 av. 18.4	45-51 av. 48
	(IH 60-63	from skull 13-14	19-20	47-51)
♀♀ (6)	54-58 av. 56.8	10.5-12.1 av. 11.2	15.3-18.4 av. 16.8	43-47 av. 44
	(IH 55-59	from skull 13-14	19-20	41-46)

1428 **Muscicapa grandis**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (18)	102-111 av. 105.9	14.1-18.3 av. 16	18.8-24.5 av. 21.8	83-97 av. 90
	(IH 100-112	from skull 18-20	23-26	87-100)
♀♀ (9)	98-107 av. 103.5	15.8-17.8 av. 16.6	18.9-21 av. 20.2	82-91 av. 86
	(IH 97-105	from skull 17-20	23-25	86-91)

1429/30 **Muscicapa macgrigoriae** subspp.

♂♂				
1429 *macgrigoriae* (4)	63-67 av. 65	9.1-10.6 av. 9.9	14.2-16.2 av. 15.4	49-51 av. 50.2
	(IH 62-67	from skull *c.* 12	*c.* 18	49-54)
1430 *signata* (5)*	64-68 av. 65.1	9-10 av. 9.5	14.6-16.8 av. 15.3	46-52 av. 50
1430 *signata* (3)	65, 66, 68	9.2, 9.7, 11	15.4, 15.6, 15.7	50, 51, 52
	(IH as in 1429)		* darker birds	
♀♀				
1429 *macgrigoriae* (1)	65	9.8	17	47
	(IH 61-65	from skull *c.* 12	*c.* 18	46-55)
1430 *signata* (6)	63-67 av. 63.2	8.3-10.7 av. 9.7	15.3-17.2 av. 16.4	47-50 av. 48.2
	(IH as in 1429)			

1431/32 **Muscicapa sundara** subspp.

♂♂				
1431 *whistleri* (5)	81-85 av. 82.8	10.5-12.7 av. 11.7	18.5-19.4 av. 18.8	58-70 av. 68
	(IH measurements as in 1432)			
1432 *sundara* (11)	80-86 av. 83.6	11.3-13.2 av. 12.2	18-19.8 av. 18.9	65-73 av. 68.1
	(IH 78-87	from skull 16-17	21-22	65-73)
♀♀				
1431 *whistleri* (4)	80, 80, 80, 83*	11.6, 12.2*, 12.4, 12.8	18, 18.1*, 18.5, 19.7	61, 64*, 64, 64
	(IH as in 1432)		* juvenile	
1432 *sundara* (17)	76-84 av. 80.3	11.2-14 av. 12.7	17.6-20.7 av. 19.7	58-65 av. 62.5
	(IH 76-83	from skull 16-17	21-23	60-68)

1434 **Muscicapa concreta cyanea**

♂♂ (2)	90, 91	17.7, 18	18.6, 19.2	69, 79
♀♀ (5)	88-89 av. 88.4	16-18 av. 17.4	19.2-21.4 av. 20.3	65-69 av. 67.2
	(♂♀ 91-93	from feathers *c.* 18-19	*c.* 23-24	66-72 Baker)

1435 **Muscicapa pallipes**

♂♂ (11)	74-79 av. 76.1	14.1-16.5 av. 15.2	16.5-19.2 av. 17.7	52-65 av. 59.9
	(IH ♂♂ 73-81	from skull 16-18	18-19	57-64)
♀♀ (7)	72-79 av. 74.5	14.3-15.3 av. 14.6	16.2-18.6 av. 17.3	54-61 av. 56.8
	(IH ♀♀ 72-76	from skull 16-17	18-19	54-62)

	Wing	Bill	Tarsus	Tail
♂♂				
1436 *poliogenys* (1)	77	13.3	18.5	66
	(IH 72-79	from skull 15-17	c. 18	60-65)
1437 *cachariensis* (1)	79	13.8	17.5	64
	(IH as in 1436)			
1438 *vernayi* (8)	72-79 av. 75	12.7-13.4 av. 13	16.3-18.5 av. 17.4	57-66 av. 61.5
	(IH 73-78	from skull 15-16	18-20	60-68)
♀♀				
1436 *poliogenys*	—	—	—	—
	(IH 71-78	from skull 15-16	c. 18	56-62)
1437 *cachariensis* (3)	72, 73, 75	13.2, 13.4, 13.5	15.5, 16.4, 18.8	59, 65, 67
	(IH as in 1436)			
1438 *vernayi* (11)	68-75 av. 71.7	12-13.5 av. 12.9	15.7-18.2 av. 18	55-59 av. 57.4
	(IH 70-74	from skull 14-16	18-20	55-60)

1439 **Muscicapa unicolor**

	Wing	Bill	Tarsus	Tail
♂♂ (6)	79-85 av. 81.3	14.2-15 av. 14.5	14.5-16.7 av. 15.5	60-68 av. 64
	(IH 80-85	from skull 17-18	17-19	70-76)
♀ (1)	78	13.8	16	65
	(IH 76-84	from skull 17-18	17-19	67-72)

1440 + EL. **Muscicapa rubeculoides** subspp.

	Wing	Bill	Tarsus	Tail
♂♂				
1440 *rubeculoides* (18)	69-75 av. 72.2	11.8-13.2 av. 12.1	15-16.9 av. 15.5	51-60 av. 54.6
	(IH 65-77	from skull 14-16	15-18	50-60)
EL. *dialilaema* (5)	66-74 av 69.4	12.1-13 av. 12.7	15-17 av. 15.9	53-61 av. 57.2
♀♀				
1440 *rubeculoides* (12)	62-71 av. 67.9	11.1-13.6 av. 12.2	14.1-19.5 av. 16	49-53 av. 51.5
	(IH 66-74	14-15	15-18	49-55)
EL. *dialilaema* (3)	66, 68. 72	12.2, 12.3. 14.7	15.2, 15.5, 16	51, 54, 58
o?				
1440 *rubeculoides* (3)	62, 69, 70	9.7, 11.3, 11.5	15, 15.6, 17.5	51, 54,—
EL. *dialilaema* (3)	64, 68, 71	11.2, 11.5, 13.1	15.1, 16.4. 16.8	55, 55. 57

1442 **Muscicapa tickelliae tickelliae**

	Wing	Bill	Tarsus	Tail
♂♂ (29)	69-77 av. 72.7	11.4-14.5 av. 13	15-17 av. 16.8	53-63 av. 57.9
♂♂ juv. (6)	67-73 av. 69.6	11.6-14.2 av. 13.4	16.1-17.2 av. 16.5	50-58 av. 54.0
	(IH ♂♂ 70-77	from skull 14-16	17-20	56-68)
♀♀ (13)	68-72 av. 70	12-14.4 av. 12.7	15.6-17.8 av. 16.7	54-62 av. 55.7
	(IH ♀♀ 68-73	from skull 14-16	16-19	54-57)
o? (6)	66-72 av. 69.8	12-13.1 av. 12.6	15-17.3 av. 16.4	52-58 av. 54.5

	Wing	Bill	Tarsus	Tail
1444 Muscicapa sordida				
♂ (1)	77	12.7	16.8	64
	(IH 6 ♂♂ 77-82	from skull 16-17	18-19	62-65
	4 ♀♀ 71-79	from skull 16-17	18-19	57-63)
1445 Muscicapa thalassina thalassina				
♂♂ (32)	79-91 av. 84.4	9.5-11 av. 10.2	12.5-16.2 av. 14.4	59-74 av. 69
	(IH 80-90	from skull 13-15	16-19	65-75)
♀♀ (17)	77-86 av. 80.4	9.5-11.7 av. 10.6	13.5-17.4 av. 14.9	59-73 av. 64
	(IH 78-84	from skull 13-15	16-19	60-71)
o? (5)	72-84 av. 81.2	9.6-11.1 av. 10.3	13.6-15.2 av. 14.2	63-68 av. 66.6
1446 Muscicapa albicaudata				
♂♂ (15)	75-83 av. 78.2	11.5-13.4 av. 12.4	14-18.5 av. 16.7	59-65 av. 62.3
	(IH 75-82	from skull 14-15	18-19	59-67)
♀♀ (8)	70-77 av. 73.8	10.8-11.5 av. 11.3	16-18 av. 16.7	57-60 av. 58 2
	(IH-74-78	from skull 13-15	18-19	56-61)
EL Muscicapa narcissima				
♂♂ (2)	69, 71	11.1, 11.2	13.7, 15	44, 45
♀ (1)	66	11.5	15.2	42
1447 Muscicapa hodgsonii hodgsonii				
♂ (1)	51	10	14.2	35
	(IH ♂♂ 47-51	from skull *c.* 11	16-17	34-35)
1448/49 Culicicapa ceylonensis subspp.				
♂♂				
1448 *calochrysea* (30)	59-67 av. 63.7	9.9-12.3 av. 10.7	—	49-58 av. 54 juveniles excluded
	(IH ♂♂ 63-68	from skull 12-14	—	51-60)
1449 *ceylonensis* (3)	59, 64, 68	10.5, 10.6, 11.2	—	50, 51, 60
	(IH ♂♂ 58-66	from skull 12-14	—	49-59)
♀♀				
1448 *calochrysea* (13)	55-63 av. 59.7	9.4-12 av. 10.5	—	46-54 av. 50.4
	(IH ♀♀ 57-66	12-14	—	50-58)
1449 *ceylonensis* (3)	54, 62, 65	10, 10.2, 10.5	—	47, 52, 55
o?	(IH 59-63	from skull 12-13	—	50-54)
1448 *calochrysea* (16)	58-66 av. 61.2	9.6-12.3 av. 10.7	—	48-58 av. 51
1449 *ceylonensis* (3)	51, 57, 64	8.8, 9.1, 10.2	—	25*, 51, 55 * mltg.
1450 Rhipidura hypoxantha				
♂♂ (17)	53-59 av. 56.5	8.3-10.4 av. 9.2	—	51-59 av. 55.2
	(IH 53-58	from skull 9-10	—	56-58)
♀♀ (5)	51-56 av. 54.4	8.8-10 av. 9.3	—	49-62 av. 56.4
	(IH 53-58	from skull 9-10	-	50-58)
o? (6)	54-57 av. 55	8.8-10 av. 9.4	--	52-57 av. 54.7

1451/53 **Rhipidura aureola** subspp.

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂				
1451 *aureola* (9)	78-86 av. 81.8	11.2-13.9 av. 12.4	—	81-94 av. 87.4
,, ,, (3) [With two central pairs of black rectrices]	77, 80, 82	12.1, 12.4, 12.5	—	82, 83, 88
	(IH ♂♂ 79-90	from skull 14-16	18-20	84-100)
1452 *compressirostris*(1)	81	13.2	—	81
	(IH ♂♂ 80-87	from skull 15-16	—	80-92)
1453 *burmanica* (1)	82	11.5	—	88
	(IH ♂♂ 83-90	from skull 14-15	—	95-102)
♀♀				
1451 *aureola* (6)	78-87 av. 81.6	11.7-13.5 av. 12.5	—	86-94 av. 89.5
,, ,, (1) [With two central pairs of black rectrices]	87	12.4	—	87
	(IH ♀♀ 72-84	from skull 13-16	—	83-98)
1452 *compressirostris* (3)	84 (3)	12.5, 12.9, 13.3	—	83, 86, 89
	(IH ♀♀ 76-85	from skull 14-15	—	80-90)

1454/1459 **Rhipidura albicollis** subspp.

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂				
1454 *canescens* (4)	74-82 av. 75.5	11.7-13.2 av. 12.4	—	93-106 av. 100.5
	(IH 6 ♂♂ 77-81 Koelz)			
1456 *stanleyi* (4)	76-81 av. 78.5	12.5-13.2 av. 12.9	—	96-103 av. 99.7
	(IH 75-84	from skull 14-16	—	96-109)
1457 *orissae* (4)	75-78 av. 76.7	12.5-13.6 av. 12.9	—	94-102 av. 97.7
	(IH as in 1455-56)			
1458 *albogularis* (7)	71-79 av. 75	12-13.4 av. 12.5	—	85-98 av. 92
	(IH ♂♂ 72-79	from skull 14-15	—	86-98)
1459 *vernayi* (6)	69-78 av. 75.8	11.8-14 av. 12.4	—	92-105 av. 96.3
	(IH ♂♂ 72-81	from skull 14-15	—	93-104)
♀♀				
1454 *canescens* (2)	72 (2)	12.2, 12.7	—	92 (2)
	(4 ♀♀ 74-76 Koelz)			

(contd.)

1454/59 **Rhipidura albicollis** (contd.)

	Wing	Bill	Tarsus	Tail
♀♀				
1455 *albicollis* (1)	79	11.7	—	100
	(IH ♀♀ 72-80	from skull 14-16	19-20	93-102)
1456 *stanleyi* (4)	75-77 av. 76.2	12.1-13.3 av. 12.6	—	97 (3)
	(IH measurements as in 1455)			
1457 *orissae* (1)	73	11.5	—	98
	(IH measurements as in 1455)			
1458 *albogularis* (6)	68-73 av. 70	10.1-13.4 av. 11.7	—	86-93 av. 89
	(IH ♀♀ 69-74	from skull 13-14	17-19	86-94)
1459 *vernayi* (1)	68	11.4	—	88
	(IH ♀♀ 70-74	from skull 13-14	18-19	88-96)

1460/64 + EL **Terpsiphone paradisi** subspp.

	Wing	Bill	Tarsus	Tail
♂♂				
1460 *leucogoster*				
(white) (8)	91-95 av. 93.2	18.2-21.7 av. 20.1	—	85*-400
	(IH white ♂♂ 88-101	from skull 23-26		104-125 streamers from base of tail 316-412)
,, ,, (rufous) (9)	84-97 av. 91.4	17.6-20.9 av. 19.5		94*-332
	(IH rufous ♂♂ 93-100	from skull 24-26		82-116 streamers 267-332)
1461 *paradisi* (white) (7)	89-97 av. 95.3	17.7-23.7 av. 20.4		105*-400
	(IH white ♂♂ 90-99	from skull 23-27		94-146 streamers 290-412)
,, ,, (rufous) (11)	84-98 av. 91	18.7-21.9 av. 20.3		94*-380+
	(IH rufous ♂♂ 92-99	from skull 22-26		100-118 streamers 299-405)
1463 *saturatior*				
(white) (2)	88, 91	19.3 (2)		95*-100*
	(IH ♂♂ 89-96	—	—	224-390 streamers)
,, ,, (rufous) (3)	83, 85, 88	19.5, 19.8, 20.2		81*, 82*, 125*+
1464 *nicobarica*				
(rufous) (3)	88 (2), **92**	18, 19.8, 20		97*, 101*, 104*
	(IH ♂♂ rufous 88-94, white 88-96	from skull 20-25		92-108, streamers 140-358)
EL *burmae* (white) (2)	**88, 91**	18, 19.3	—	166, 271
EL *affinis* (white) (1)	90	17.7	—	113*
EL *incei* (3)	89*, 94 (2)	16.5*, 17, 18.7	—	86*, 235, 275
♀♀				* without streamers
1460 *leucogoster* (9)	79-93 av. 88	17.3-21 av. 19.4	—	84-130+ av. 103
	(IH ♀♀ 82-92	from skull 22-25	—	88-106)

1460/64 + EL **Terpsiphone paradisi** subspp. (contd.)

	Wing	Bill	Tarsus	Tail
♀♀				
1461 *paradisi* (9)	84-92 av. 88.5	17.7-21 av. 19.2	—	85-125 av. 97
	(IH ♀♀ 85-92	from skull 22-24	—	86-110)
1462 *ceylonensis* (1)	87	20	—	100
	(IH 1 ♀ 92	from skull 25	—	116)
1463 *saturatior* (1)	83	19.2	—	88
	(IH ♀♀ 87-92	—	—	—)
1464 *nicobarica* (2)	82, 86	18.1, 19	—	82, 83
EL *affinis* (1)	82	21	—	84

1465/69 **Monarcha azurea** subspp.

	Wing	Bill	Tarsus	Tail
♂♂				
1465 *styani* (a) (4)	69, 71, 72, 73	13.2, 13.2, 13.5, 14.4	13.7, 14.5, 16, 16.7	67, 70, 74, —
.. *styani* (b)(21)	66-73 av. 70.3	11.2-14.4 av. 13	13.3-17 av. 15.2	62-76 av. 69.6
	(IH ♂♂ 64-75	from skull 14-17	16-18	65-76)
1467 *tytleri* (6)	71-75 av. 74	12.7-14.5 av. 13.7	14.8-16 av. 15.4	71-77 av. 74
	(IH 3 ♂♂ 71-75	—	—	70-73)
1468 *idiochroa* (2)	71, 74	14.1, 14.7	15.3, 16.6	74 (2)
	(IH 1 ♂ 76	—	—	72)
1469 *nicobarica* (5)	62-67 av. 65.4	11.8-14 av. 13.1	15.3-17 av. 15.8	60-66 av. 63
	(IH 15 ♂♂ 63-73	—	—	56-78)
♀♀				
1465 *styani* (a)(8)	65-69 av. 67.3	13-15.4 av. 13.9	14.1-16.7 av. 15.2	63-74 av. 68
.. ,, (b)(21)	64-76 av. 68.7	12.6-15.6 av. 13.4	13.5-17.5 av. 15.3	61-67 av. 68.9
	(IH ♀♀ 66-76	from skull 14-17	16-18	65-74)
1466 *ceylonensis* (1)	67	11.8	14.8	68
	(IH 7 ♀♀ 67-71	from skull 14-15	15-16	65-70)
1467 *tytleri* (2)	69, 73	13.8, 14.2	15, 16.2	70, 71
	(IH 2 ♀♀ 71-73	—	—	69-72)
1468 *idiochroa* (2)	73, 73.5	13.7, 14.3	17, 17.2	66, 68
	(IH 3 ♀♀ 72-77	—	—	68-70)
1469 *nicobarica* (1)	63	12.5	16.7	62
	(IH 9 ♀♀ 65-70	—	—	57-67)

1470 **Pachycephala grisola**

	Wing	Bill	Tarsus	Tail
♂♂ (5)	81-84 av. 81.8	15-16.5 av. 15.9	18.5-20 av. 19.4	58-64 av. 61.6
o? (3)	79, 83, 84	16.4, 16.7, 17.5	17.5, 19.3, 19.5	64 (2), 65
	(IH ♂♀ 81-89	—	c. 23	55-61
				Baker)

(to be continued)

OBSERVATIONS ON THE HABITAT-DISTRIBUTION OF ORCHIDS OF ARUNACHAL PRADESH[1]

SADANAND N. HEGDE[2]

(With two plates and a text-figure)

Observations on the habitat distribution of 208 species of Orchids of Arunachal Pradesh have yielded interesting data. Based on the variations in altitude, temperature, rainfall and humidity along with the type of vegetation, four orchid zones have been recognised which seem to determine primarily, the habitat of both terrestrial and epiphytic orchids. Other factors like light and shade, phorophyte type and quality, soil pH, type and organic content also seem to be responsible for determining the habitat and distribution of individual species. Details are given under each zone and a list of species occurring in each of them is given in a tabular form indicating the area of distribution of the individual species. Competition among and between the orchid species and other associate plants appears to be an important factor responsible for migration. Based on these observations and floristic analysis it appears that the species of orchids from a particular region tend to migrate to the neighbouring regions with favourable habitat conditions in a radiating pattern and the rate of distribution is inversely proportionate to the distance of their migration.

INTRODUCTION

Arunachal Pradesh comprising an area of 83,578 sq. km lying between the parallels of latitude 26°30′ and 29°28′ North and meridian of longitude 91°36′ and 97°25′ East is situated towards the extreme North-East India. This region is considered to be one of the richest floristic regions of the world and phytogeographically forms a meeting ground of the Indo-Malayasian and Sino-Japanese floras (Sahni 1979). It is a mountainous State of the Eastern Himalayas with the altitudinal variations ranging from 170 to 5000 m resulting in varying climatic zones of hot valleys at the foothill regions and of the snow-clad peaks at higher elevations. It receives an annual rainfall ranging from 700 mm to 6500 mm resulting in big and small rivers and rivulets and therefore enjoys a humid climate throughout the year in varying degrees. These elements have favoured the vegetation to flourish in all its diversity of composition.

Among the various floristic compositions, orchids are one of the major groups found in almost all the vegetational types. Several explorers like Bose (1940), Burkill (1924), Deb and Dutta (1974), Panigrahi and Naik (1961), Panigrahi and Joseph (1966), Rao and Deori (1980 a,b) & Sahni (1969, 1979) have noted Orchidaceae as the richest family consisting of the maximum number of species in Arunachal Pradesh. In preliminary observations on the orchids of this territory, (Hegde 1980) listed 170 species distributed in various vegetational types. Of late, there have also been reports of new species and distributional records from this territory (Joseph & Rao 1979, Hegde 1981a and b, Joseph, Hegde & Rao 1981, Jain & Das 1978).

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Although there are about 350 species of orchids so far recorded in this territory, sufficient information is not available about them, regarding their habitat, ecology and distribution of the individual species. Therefore, in the present communication field observations made for the last four years on 208 species pertaining to their habit, habitat and distribution pattern have been presented and discussed.

Material and Methods

While surveying and demarcating the areas of occurrence of orchids of Arunachal Pradesh, data pertaining to the habit and habitat of individual species and the factors like type of vegetation, elevation, light condition, soil or phorophyte quality and other general environmental factors were noted. The temperature and rainfall data were subsequently collected from district Statistical Officers of the respective districts. All these data were analysed and incorporated in Tables 2 and 3.

The soil samples of six terrestrial orchids were analysed by the Mobile Soil Testing Laboratory, Tezpur and are presented in Table 1 below:

Table 1

Analysis of terrestrial orchid soil samples

Soil Samples of species 1	pH 2	Org. C% 3	Soil Type & Texture 4
Paphiopedilum fairieanum	6.6	1.82	Loamy (Diatomaceous)
Phaius maculatus	5.90–6.2	Maximum	Humus rock soil
Epipogium sp.	6.72–6.90	,,	— do —
Malaxis josephiana	5.60–6.90	0.50–0.80	— do —
Arundina graminifolia	4.50	0.41	Medium Clay
Acanthephippium sylhetense	5.30	Maximum	— do —

The live specimens collected were introduced in the Orchidarium, Tipi and Orchid Sanctuary, Sessa, and properly labelled. A portion of each specimen with flowers was processed for the herbarium and maintained at the Orchid Herbarium Tipi. The specimens were identified with the help of FLORAS and also by comparing the Herbarium (ASSAM) of the Botanical Survey of India, EC, Shillong.

Observations

As mentioned in the introduction, Arunachal Pradesh is essentially mountainous with altitudinal variations ranging from 170 to 5000 m, receiving an annual rainfall ranging between 700 mm and 6500 mm. It enjoys a humid climate in varying degrees throughout the year. These factors have influenced the type of vegetation which has in turn influenced the habitat of various orchid species. Based on the observations on the habitat and place of occurrence in different vegetational types and altitudes with varying temperature and rainfall, four orchid zones have been recognised as in Table 2.

Under each of the above broad classifications, the species of orchids with that particular habitat-requirement are found to grow in varying density. Accordingly, they have been listed under each zone with relevant remarks on habit and frequency of occurrence (Table 3). Certain species that occur overlappingly in

TABLE 2

Orchid Zone	Type of Vegetation	Elevation in metre	Remarks
1	Tropical Evergreen rain Forest	170–900	Warm, humid (90%) with heavy rainfall.
2	Sub-tropical Forest	900–1,800	Cooler, humid with moderate rainfall.
a.	Mixed wet Forest		Wet and dense.
b.	Mixed or pine (Partially dry) Forest		Partially dry and open.
3	Temperate Forest	1,800–3,500	Frost in winter with brief snowing, 85% humid, with moderate rainfall.
4	Alpine Forest	3,500–5,000	4-6 months snow covered with less rain.

different zones under favourable habitat conditions have also been included in the list separately.

The salient features of each zone and the habitat conditions of the species occurring in them are given below (also see Table 3).

ZONE I

This zone is characterised by broad-leaved evergreen vegetation with high rainfall, warm temperature, and humidity (90 to 100%). Some common trees (Phorophytes) that occur here are *Castanopsis tribuloides, Terminalia myriocarpa, Canarium resiniferum, Artocarpus chaplasha, Altingia exulsa,* etc. Several epiphytic orchids thrive well on them in abundance (cf. Table 3). At times, as many as 20-30 species of orchids are found to occur on a single large tree. Often these epiphytes are found singly or in large numbers along with other aroids and ferns. Most common ones among them are the species of *Aerides, Bulbophyllum, Coelogyne, Cymbidium, Dendrobium, Eria,* etc. It is interesting to note that species like *Cymbidium aloifolium, Dendrobium fimbriatum* v. *oculatum* and *D. moschatum* are generally found in sunny spots of the tree-trunk, others like *Aerides fieldingii, A. multiflorum, Cymbidium pendulum, Eria flava* in partial shade conditions generally occupying the top canopy and species like *Dendrobium cumulatum, D. aduncum, Ornithochilus fuscus, Pteroceras suaveolens* in dense shade areas of the trees or middle canopy in tropical vegetation.

Among the terrestrial orchids, *Arundina graminifolia, Goodyera procera, Spiranthes lancea, Spathoglottis pubescens* var. *parviflora* are sun-loving types invariably found in open type of forests or sun-exposed newly cleared areas. The former two appear in newly cleared areas especially on earth-cut-ends, as pioneers. On the other hand, *Acanthephippium sylhetense, Anoectochilus roxburghii* var. *regalis, Cymbidium munronianum,* etc. are shade loving types found in damp humus soil.

ZONE II

This zone receives comparatively lesser rains. However it is characteristically cooler and humid. The common phorophytes in this zone are *Schima wallichii* and *Castanopsis indica.* Even the moss-covered rocks form congenial habitat for orchids. The following two forms of vegetation of this zone greatly

TABLE 3

LIST OF ORCHIDS OCCURRING UNDER EACH ORCHID ZONE

Following abbreviations and symbols have been used in the Table:

* = Burmese elements.	S = Saprophyte.
+ = West Himalayan elements.	R = Rare.
E = Epiphyte.	En = Endangered.
T = Terrestrial.	C = Common.
a = Zone IIa.	b = Zone IIb.

ZONE I:

Name of Species

Acampe
papillosa Hochr. + EC
rigida (Buch.-Ham. ex Sm.) Lindl. EC
Acanthephippium sylhetense Lindl. TR
Aerides
multiflorum Roxb. EC
odoratum Lour. + EC
williamsii Warn. EC
Agrostophyllum
brevipes K. & P. EC
Anoectochilus
roxburghii var. *regalis* (Bl.) U. C. Pradhan TC
Arundina
graminifolia (Don) Hochr. TC
Bulbophyllum
capilipes par & Reichb. f. ER
clarkeanum K. & P. EC
delitescens Hance ER
**hirtum* Lindl. EC
reptans Lindl. EC
sikkimense (K. & P.) J. J. Sm. EC
Calanthe
clavata Lindl. TC
Ceratostylis
teres Reichb. f. EC
Chiloschista
lunifera (Hook. f.) J.J. Sm. EC
Cleisostoma
**aspersum* (Reichb. f.) Garay ER
filiforme (Lindl.) Garay EC
subulatum Bl. EC
Coelogyne
flavida Wall. ex Lindl. EC
**rigida* par et Reichb. f. ER
Cymbidium
**aloifolium* (L.) Sw. + EC
**eburneum* v. *parishii* (Reichb. f.) Hook. f. EEn
munronianum K.&P. TR
pendulum Sw. + EC
Dendrobium
acinaciforme Roxb. EC
aduncum Wall. EC
**anceps* Sw. EC
aphyllum (Roxb.) Fisch. + EC
**cathcartii* Hook. f. EC
cumulatum Lindl. EC
fimbriatum v. *occulatum* Hook. f. + EC
lituiflorum Lindl. EC
**moschatum* Sw. + EC
nobile Lindl. EC
terminale Par. & Reichb. f. EC
transparens Lindl. + EC
Diplomeris
hirsuta Lindl. TEN
Eria
acervata (D. Don) Handl.-Mazz. EC
**biflora* Griff. EC
**flava* Lindl. + EC
**fragrans* Reichb. f. EC
pannea Lindl. EC
stricta Lindl. EC
Gastrochilus
**calceolaris* (Sm.) Don + EC
crassilabris (K. & P.) Garay EC
dasypogon (Sm.) O. K. EC
Geodorum
**purpureum* R.Br. + TC
Goodyera
procera Hook. f. + TC
Kingidium
deliciosum (Roxb.) Sweet. EC

Liparis
duthiei Hook. f. + EC
longipes Lindl. + EC
plantaginea Lindl. EC
Luisia
teretifolia Gaud. + TC
trichorhiza Bl. EC
Malaxis
latifolia Sw. ex Rees. + TC
wrayii Hook. f. TR
Micropera
**mannii* (Hook. f.) Tang. & Wang. EC
obtusa (Lindl.) Tang. & Wang. EC
Oberonia
iridifolia Lindl. EC
Ornithochilus
fuscus Wall. ex Lindl. + EC
Papilionanthe
**teres* (Roxb.) Schlecht. EC
Phalaenopsis
**parishii Reichb. f.* EC
Pomatocalpa
**armigerum* (K. & P.) Tamg. & Wang EC
**wendlandorum* (Reichb. f.) J. J. Sm. ER
Pteroceras
suaveolens (Roxb.) Holtt. EC
Rhyncostylis
**retusa* (L.) Bl. + EC
Saccolabium
trichromum Reichb. f. EC
Spathoglottis
pubescens v. *parviflora* Lindl. TR
Trixspermum
pygmaeum (K. & P.) Holtt. EC
Tylostylis
**discolor* Hook. f. EC
Vanda
coerulea Griff. ex Lindl. EEn
**coerulescens* Griff. ER
Zeuxine
strateumatica (L.) Schltr. TC

ZONE II :

Acanthephippium
striatum Lindl. TR
Anthogonium
**gracile* Lindl. a, TC
Arachnis
clarkii (Reichb. f.) J. J. Sm. EEn
Bulbophyllum
acutifolium Reichb. f. ER
cauliflorum Hook. f. a, EC
cylindraecum Lindl. a, EC
guttulatum Wall. ex Hook. f. a, EC
helenae (O.K.) J. J. Sm. a, EC
leopardinum (Wall.) Lindl. a, EC
Calanthe
alismaefolia Lindl. + a, TR
bilba Lindl. a, TC
densiflora Lindl. b, TR
mannii Hook. f. + b, TC
Ceratostylis
himalaica Hook. f. EC
**sagittiformae* Garay ER
**simondii* (Gagnep) Seiden. f. ER
williamsonii (Reichb. f.) Garay EEn
Coelogyne
corymbosa Lindl. EC
elata Lindl. + b, EC
**flaccida* Lindl. EC
longipes Lindl. EC
**ovalis* Lindl. + EC
**prolifera* Lindl. b, EC
schultesii Jain et Das b, EC
Cryptochilus
sanguinea Wall. a. EC
Cymbidium
devonianum Paxt. b, EREn
macrorhizon Lindl. + a, b. TSR
mastersii Grill. EC
Dendrobium
chrysanthum Wall. + a, EC
Chrysotoxum Lindl. ER
**densiflorum* Lindl. EEn
**falconeri* Hook. f. a, EC
**farmeri* Paxt. a, ER
**gibsonii* Lindl. EC
**heterocarpum* Wall. ex Lindl. a, EC
**hookerianum* Lindl. a, EC
longicornu Lindl. ex wall. a, EC
nobile Lindl. EC
var. *schroederianum* Veitch. ER
**pendulum* Roxb. ER
primulinum + Lindl. ER
wardianum Warnr. a. EC
Epigeneium
amplum (Lindl.) summrh. a, EC
rotundatum Reichb. f. a, EC
Eria
**acervata* Lindl. a, EC

amica Reichb. f. a, EC
bractescens Lindl. a, EC
connata Joseph, Hegde & Rao a, EC
coronaria Reichb. f. EC
graminifolia Lindl. a, EC
hindii summerh. a, EC
rufinula Reichb. f. a, EC
Gastrochilus
intermedius (Griff. ex Lindl.) O.K. a, EC
Gastrochilus sp. a, EC
Habenaria
latilabris Hook. f. + a, TC
polytricha (Hook. f.) U. C. Pradhan a, TC
prainii Hook. f. a. TC
**Kingidium*
taeniale (Lindl.) P. F. Hunt. + a, ER
Liparis
delicatula Hook. f. EC
Luisia
inconspicua Hook. f. + a, EC
Monomeria
barbata Lindl. + a, EC
Nervilia
gammieana (K. & P.) Schltr. TC
Oberonia
anthropophora Lindl. a, ER
caulescens Lindl. EC
myriantha Lindl. a, EC
longilabris K. & P. EC
Otochilus
**fusca* Lindl. EC
Phaius
maculatus Lindl. a, TC
tankervilliae Lindl. TR
Pholidota
**articulata* Lindl. EC
**rubra* Lindl. EC
Phreatia elegans Lindl. a, EC
Epipogium roseum (D. Don) Lindl. SR
Thelasis
longifolia Hook. f. a, EC
Uncifera
obtusifolia Lindl. EC
Vanda
alpina Lindl. + a, ER
cristata Lindl. + a, EC

ZONE III :

Bulbophyllum
eublepharum Reichb. f. EC
wallichii Lindl. EC
Cleisostoma
**racemiferum* (Lindl.) Garay EC
Coelogyne
barbata Griff. E. En
**fuscescens* Lindl. EC
griffithii Hook. f. ER
**nitida* (Wall. ex Don) Lindl. EC
occultata Hook. f. EC
punctulata Lindl. EC
Cymbidium
elegans Lindl. E. En
giganteum Wall. E. En
grandiflorum Guill. E. En
longifolium D. Don + E. En
Dendrobium
**jenkinsii* Wall. ex Lindl. EC
Epigeneium
fuscescens (Griff.) Summerh. EC
Eria
**spicata* (D. Don) Hand-Mazz. + EC
Galeola
falconeri Hook. f. + S. En
lindleyana Reichb. f. S. En
Gastrochilus
acutifolium (Lindl.) O. K. a. EC
Herminium
angustifolium Benth. TC
Liparis
bootanensis Griff. a, EC
compressa Lindl. ER
Oberonia
pyrulifera Lindl. EC
Panisea
tricallosa Rolfe. ER
Paphiopedilum
fairieanum (Lindl.) Pfitz. T. En
Pholidota
imbricata Lindl. + EC
Pleione
**praecox* (Sm.) D. Don + EC
Satyrium
nepalense D. Don + TC

ZONE IV :

Bulbophyllum
retusiusculum Rchb. f. EC
Habenaria
cumminsiana K. & P. TR

Herminium
longilobatum Hegde et Rao

ORCHIDS COMMON TO ZONE I AND II:

Agrostophyllum
**khasianum* Griff. EC
Bulbophyllum
**odoratissimum* Lindl. EC
**protractum* Hook. f. EC
scabratum Reichb. f. + EC
Calanthe
masuca (D. Don) Lindl. TC
Chrysoglossum
erraticum Hook. f. TR
Dendrobium
**bicameratum* Lindl. EC
Jenkinsii Wall. ex Lindl. EC
sulcatum Lindl. ER
Ephemerantha
**macraei* Lindl. EC
Eria
carinata Gibs.
paniculata Lindl. EC
Eulophia
zollingeri (Reichb. f.) Sm. SR
Goodyera
procera Hook. f. TC
Liparis
mannii Reichb. f. EC
Malaxis
acuminata var. *biloba* Hunt. & Summerh. TC
khasianum (Hook. f.) O. K. TC
josephiana (Reichb. f.) O. K. TR
Nervilia
macroglossa Hook. f. TC
Otochilus
alba Lindl. EC
Phalaenopsis
mannii Reichb. f. EC
Schoenorchis
gemmata (Lindl.) J. J. Sm. EC
Smitinandia
**micrantha* (Lindl.) Holtt. + EC
Spathoglottis
pubescens
var. *parviflora* Lindl. TR
Spiranthes
lancea (Thumb. ex Sw.)
B. B. & V. S. + TC

influence the occurrence of orchids and their habitat:

a) *Mixed Wet Forest Belt*. This forest belt mostly remains wet and cool. Every phorophyte is heavily moss-covered and forms congenial habitat for orchids. The epiphytic species of *Bulbophyllum*, *Coelogyne*, *Dendrobium*, *Eria*, are invariably found on the tree-trunks and moss-covered rocks in exposed areas. While species like *Dendrobium densiflorum*, *Coelogyne fuscescens* are generally seen in sun-exposed areas, those of *Dendrobium falconeri*, *D. chrysanthum*, *D. wardianum*, *Dortis taenialis*, etc. are in partially exposed portions of the phorophyte. However, *Arachnis clarkii*, *Cleisostoma aspersum*, *Cymbidium devonianum* are found under shady portions indicating their shade requirements.

On damp forest floors full of humus and in heavy shade *Phaius mishmensis*, *Tainia* sp., *Habenaria* sp. and *Calanthe alismaefolia* are generally seen. Occasionally another terrestrial, viz. *Acanthephippium striatum* is noticed. The most interesting saprophyte *Eulophia zollingeri* occurs in this belt under thickets in damp forest floor, and *Epipogium roseum* in decomposed wood matter.

In partially exposed areas, the terrestrial forms like *Malaxis khasiana*, and *Nervilia* sp. are commonly seen. Rarely one comes across another interesting saprophytic *Cymbidium*, *C. macrorhyzon* on the damp humus forest floor.

b) *Mixed or Pine (Partially dry) forest Belt*. This belt is characterised by less rain, dry winter and is mostly inhabited by the *Pinus*, *Quercus* and *Rhododendron* species. The forest is mostly open allowing considerable sunlight. The epiphytic orchids like *Dendrobium fimbriatum* var. *oculatum*, *Coelogyne elata*, *C. occultata*, *Eria* sp., *Otochilus fusca*, *Cleisostoma racemiferum* are common. How-

Above: Galeola lindleyana a giant saprophyte in its natural habitat.
Left-above: Epipogium sp. a rare saprophyte typical of primitive forest in subtropical zone. below: Paphiopedilum fairieanum an endangered species in its natural habitat.

(*Photos :* Author)

Above : A branch of *Quercus* tree loaded with orchids.
Below : Several epiphytic orchids on moss-covered rock in subtropical zone.
Right : A tree with several species of orchids competing with epiphytic ferns and lichens.
(*Photos* : Author)

ever, on pine trees no orchid is generally seen excepting *Otochilus fusca* which is very rarely noticed on them. The terrestrial species generally found here are those of *Habenaria* and *Satyrium*. The species like *Calanthe densiflora* and *Phaius tankervilliae* are found in wet shady and humus filled calcareous soil.

In grass land formations of this belt one of the spectacular Orchids *Paphiopedilum fartieanum* popularly known as the 'Lost Lady Slipper Orchid' is found occurring in isolated patches in rock crevices or calcareous soil along with the members of Crassulaceae. They also occur in association with grass in Lower temperate zone in *Pine-Quercus-Rhododendron* forest types (Hegde 1981) in sun-exposed areas.

ZONE III

This zone, mostly inhabited by *Magnolia, Quercus,* and *Pinus* species experiences sufficient rain and hence may be considered wet. In winter there is frost in the form of heavy fog and occasionally experiences snowfall for a short period. The common epiphytes collected in this zone are *Cymbidium* sp., *Coelogyne* sp., *Bulbophyllum* sp., *Eria coronaria, Pleione praecox, Otochilus* sp. etc. These species are also seen growing on moss-covered rocks. Rarely, one comes across the spectacular *Cymbidiums*, i.e. *C. grandiflorum* and *C. giganteum* on *Quercus* trees or moss-covered rocky terrains. In the exposed terrains the terrestrials like *Calanthe mannii, Habenaria* sp. etc., grow in large numbers. The spectacular saprophyte-*Galeola lindleyana* with its golden yellow flowers on 2-4 m high spikes are found occurring in this zone in damp forest floors on decaying wood. Another saprophyte, *G. falconeri* commonly found in zone II is also seen occurring in this zone.

ZONE IV

This zone is snow-covered for about 5-6 months. A few terrestrial orchids like *Habenaria, Herminium*, and occasionally a species of *Bulbophyllum* are found in this zone.

Floristic Analysis

Among the orchids in the present study, the sub-tribe Sarcanthinae is the most heterogenous group consisting of 20 genera and 39 species. Among the genera, *Dendrobium* forms the largest taxon consisting of 28 species.

A perusal of the distribution of the species in the present context reveals that the following species that occur in Arunachal Pradesh are widely distributed in India, down up to Western Ghat ranges and the Nilgiris, up to Garhwal ranges of Himalayas in the west and down South East up to Burma (cf. Index Kewensis I & II and Floras viz., by Banerjee and Thapa 1978; Duthie 1906; Grant 1895; Hooker *et al.* 1883; King and Pantling 1898; Pradhan 1976 and 1979).

1. *Spiranthes lancea.*
2. *Rhynchostylis retusa*
3. *Pholidota imbricata*
4. *Geodorum purpureum*
5. *Cymbidium aloifolium*
6. *Luisia teretifolia*
7. *Arundina graminifolia*
8. *Zeuxine strateumatica*

The following 20 species are also found in Malaya (Holttum 1964):

1. *Arundina graminifolia*, 2. *Bulbophyllum capillipes* Par. et Reichb. f., 3. *B. retusiusculum*, 4. *Calanthe masuca*, 5. *Cleisostoma subulatum* Bl. 6. *C. williamsonii*, 7. *Cymbidium eburneum* var. *parishii*, 8. *Epimerantha macraei*, 9. *Eria biflora* Griff., 10. *Eria pannea*, 11. *Eulophia zollingeri*, 12. *Gastrochilus calceolaris*, 13. *Liparis bootanensis*. 14. *L. com-*

pressa, 15. *Oberonia anthropophora* Lindl., 16. *Phaius tankervilliae*, 17. *Pholidota articulata*, 18. *Rhynchostylis retusa*, 19. *Spiranthes lancea*, 20. *Epipogum roseum*.

Out of the 208 species enumerated in this paper 68 species (*) are distributed in Burma (Grant 1895) and 46 species (+) in west Himalayan ranges (Banerji & Thapa 1978, Duthie 1906, Hooker *et al.* 1888) (Table 3).

The following 11 species also occur in Western Ghat Ranges of South India (Santapau & Kapadia 1966):

1. *Arundina graminifolia*, 2. *Bulbophyllum acutifolium*, 3. *Calanthe masuca*, 4. *Cymbidium alofolium*, 5. *Gastrochilus dasypogon* 6. *Geodorum purpureum*, 7. *Luisia teretifolia*, 8. *Pholidota imbricata*, 9. *Rhynchostylis retusa*, 10. *Satyrium nepalense*, 11. *Spiranthes lancea*.

It is interesting also to note that the following elements represented here also occur in China, (Index Kewensis Vols. I & II): 1. *Aerides odoratum*, 2. *Bulbophyllum delitescens* (also in Hongkong), 3. *Dendrobium nobile*, 4. *Ornithochilus fuscus*, 5. *Phaius maculatus*, 6. *Spathoglottis pubescens* var. *parviflora*.

A few other species like *Micropera obtusa*, *Bulbophyllum leopardinum*, *Pteroceras suaveolens*, *Cleisostoma subulatum* are also reported from Java.

Further, it is interesting to note that the orchid flora of the Western part of Arunachal Pradesh (Kameng) is to a certain extent different from the eastern part of the State (i.e. Tirap). Out of the 50 species reported by Panigrahi and Joseph (1966) from Tirap Forest 15 species are yet to be found in Kameng District.

Discussion

From the preliminary survey made, it is clear that Arunachal Pradesh is rich in Orchid Flora not only in the number of species but also in the density of occurrence (Hegde 1980a). The altitudinal variations resulting in diverse climatic conditions accompanied by varying rainfall, humidity, light and temperature (Table 2) seem to be responsible for the rich occurrence of orchids finding themselves in a conducive habitat.

The habitat of terrestrial orchids depends a lot upon the soil type (humus or dry), soil quality, exposure (shade or sun). temperature and rainfall. Competition for space and nutrition appears to be another important factor. The species of *Arundina graminifolia*, *Goodyera procera*, etc. are found in the newly cleared fresh soil areas where other plant species have not yet migrated and do not compete for space & nutrition. As shown in the table 1, pH of the soil, its organic content and texture appear to be critical factors for terrestrial orchids. The occurrence of specific mycorhyzal fungus in the microclimate might also influence the habitat of the orchids. According to Case (1962) the environmental factors that categorize orchid habitats are: 1. Soil requirements (clay, sandy or peaty, black humus), 2. freedom from competition, 3. Mycorrhiza, 4. Acidity-basicity, 5. Soil temperature & 6. Exposure. For epiphytic orchids the habitat depends upon exposure, temperature, amount of rainfall and humidity, in addition to phorophyte quality (Case 1962). In Arunachal Pradesh, Kataki (1978) has noted about 15 phorophytes (host-trees) on which orchids generally are found. In the present study the common phorophytes have been noted under each zone. However, phorophyte specificity could not be recognised for any species of orchids. Sanford (1974) discussing about phorophyte specificity opines that totality of habitat is important as against a single combination of characters like phorophyte specificity. Many a times, it has also been observed that the epiphytic orchids are

found growing profusely on moss-covered rocks under suitable conditions. However, on trees having smooth or peeling-off-bark, orchids are generally not found. Therefore, phorophyte bark qualities such as rough or smooth, peeling or non-peeling, resinous or non-resinous types appear to influence the habitat of epiphytic orchids.

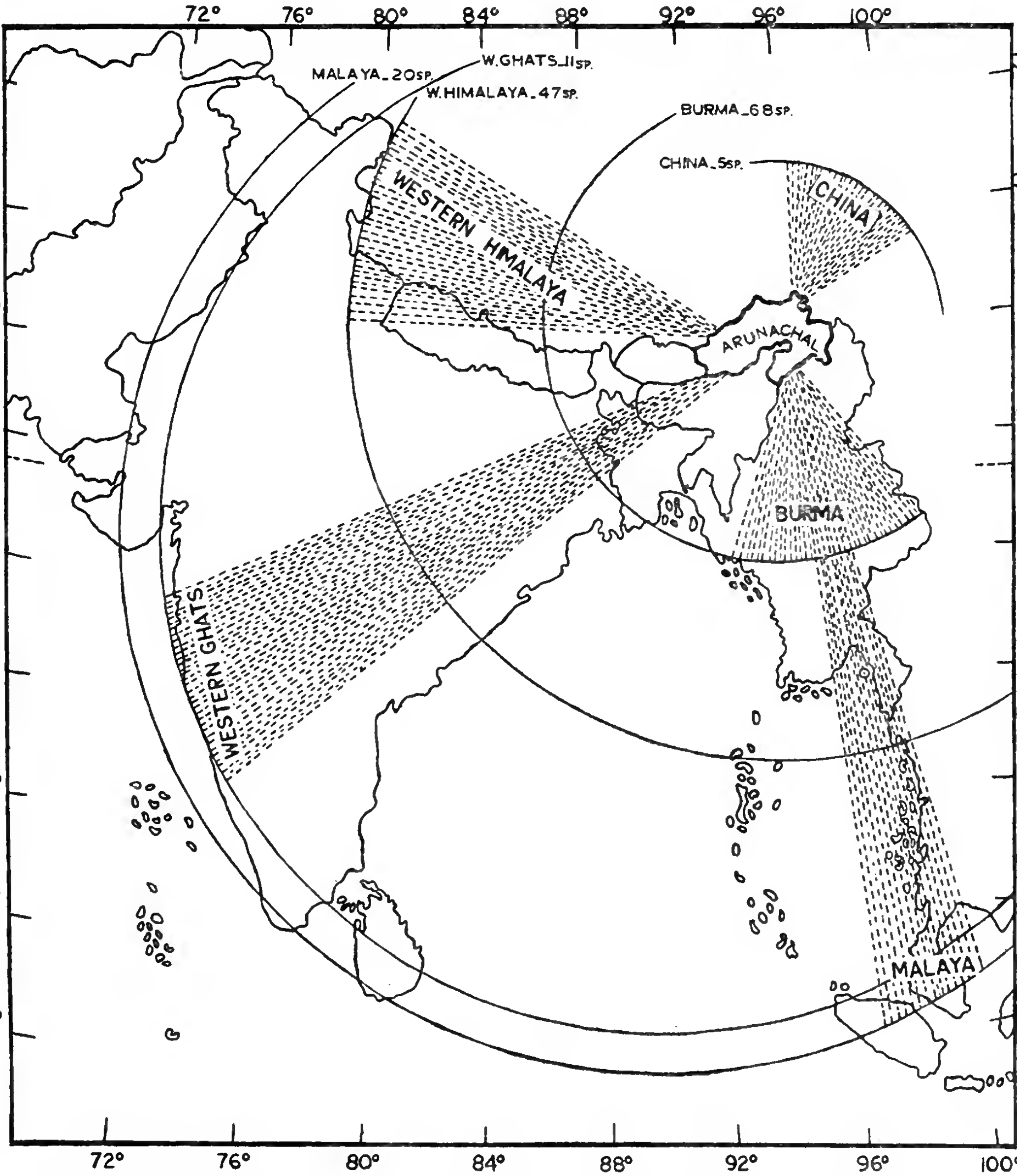

Fig. 1. Map showing distribution pattern of species of orchids from Arunachal Pradesh.

However, for both forms of orchids-terrestrial or epiphytic the vegetational types in which the individual orchids inhabit appear to be important factors. Pradhan (1976) in his book on "Indian Orchids" has out-lined five major orchid zones based on altitudinal zonations. In the present study, however, the 4 main orchid zones as described earlier are based on the vegetational types recognised by Rao and Panigrahi (1961) and Sahni (1969). These zones appear to have greater impact on determining the habitat and distribution.

In the present study it has also been observed (Table 3) that in a particular habitat, several species of Orchids occur. As noted in zone I, as many as 20-30 species of orchids are found on a single large tree, thereby suggesting competition between and among the orchid species in addition to other orchids and ferns. This obviously results in the migration to another congenial habitat with less competition, through dispersal of seeds in all the favourable directions in a radiating pattern after attaining the so called "ecological niche". Sanford (1974), discussing the ecology of orchids, is of the opinion that there exists gradual short-range and long-range dispersal mechanism which represents the infra-structure of distribution. Arunachal Pradesh with diverse ecological habitat has large number of species occurring in abundance and distributed far and wide. This warrants one to believe that both short-range and long-range dispersal and distribution are in operation.

A perusal of distribution pattern of orchids in the present study has revealed that out of 208 species studied in Arunachal Pradesh, 68 are found in Burma, 46 in West Himalayas, 20 in Malaya, 11 in South India, 6 in China, 4 in Java thereby suggesting a phytogeographical link far and wide.

While continuity of link, exists from west Himalayas through Sikkim, a greater affinity and link is evident towards South east along Burma to Malaya. Towards China, however, the snowzone of the East Himalayas might be acting as a barrier. Possible explanation for such a phytogeographical link and distribution appears to be short-range and long-range dispersal in a radiating pattern. Further a careful examination of the distribution pattern in the present study reveals that the number of species distributed is almost inversely proportionate to the distance of their migration (Fig. 1). It appears therefore, the species of orchids from a particular region (say, Arunachal Pradesh in the present context) tend to disperse and migrate to the neighbouring regions with favouring habitat — conditions after reaching the so called "ecological niche" and, the rate of distribution is inversely proportionate to the distance of their migration.

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COMMENTS ON RIPLEY'S "A SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN" — SECOND EDITION (1982)[1]

BISWAMOY BISWAS[2]

Revised, enlarged, and greatly improved, this second edition of the SYNOPSIS appears 21 years after the publication of the first. The issue of this edition is something of an event since the book which has so long been regarded as one of the most complete and invaluable compendium on Indian ornithology. has been out of print for several years.

The second edition of the SYNOPSIS differs in someways from the first. There is a reduction in the number of illustrations, and the chapter on zoogeographic considerations (including the list of Indian endemic species) is gone. A welcome chapter explaining the new geographical names in relation to the older ones is added, and the chapter on forest types is thoroughly revised. In comparison to the first edition's 402 genera this edition lists 400, and 35 species and 40 subspecies are added to the list.

The present edition is published in 1982, but no cut-off date is given, so that in some cases updating does not seem quite complete, e.g. the author's own work on *Actinodura nipalensis/waldeni* published on 12 February 1980 in the Journal of the Bombay Natural History Society is not covered, while his later work on *Brachypteryx cryptica*[3] published on 21 November 1980 in the same journal is listed.

[1] Accepted April 1983.

[2] *Present address*: Zoological Survey of India, Indian Museum, Calcutta 700 016.

[3] Since synonymised with *Trichastoma tickelli assamense* (*see JBNHS* 81(3): 700-701) —EDS.

I have a few more comments to make chiefly to supplement the information already contained in the book.

p. 6, no. 15 **Fregetta tropica melanogaster** (Gould) : There is a sight record of this bird from Car Nicobar Island by Abdulali (1981, JBNHS 78 : 46).

p. 7, no. 17 **Phaethon aethereus indicus** Hume: and p. 53, no. 175 **Icthyophaga ichthyaetus ichthyaetus** (Horsfield): Andaman Islands should be included in the ranges of these birds.

p. 7, no. 18 **Phaethon rubricauda rubricauda** Boddaert : '(?)' after Nicobars should be deleted.

p. 7, no. 19 **Phaethon lepturus lepturus** Daudin : Abdulali (1981, *JBNHS* 78: 46) has recorded it from Car Nicobar Island.

p. 12, no. 33 **Ardea insignis** Hume : The date of publication of Hume's reference is 1878.

p. 29, no. 88 **Dendrocygna javanica** (Horsfield): Abdulali (1965), *JBNHS* 61: 504-505) states that it has been reported from the Andamans by Butler, Osmaston, Davison, as well as by himself, and from the Nicobars by Butler.

p. 55, no. 181 **Gyps himalayensis** Hume: The type-locality was restricted to Simla, northern Punjab [=Himachal Pradesh] by Baker (1922, *JBNHS* 28: 583).

p. 60. Add no. 201a **Spilornis cheela malayensis** Swann : Recorded from Great Nicobar Island by Saha & Dasgupta (1980, *Rec. zool. Surv. India* 77: 89).

p. 60, no. 203 **Pandion haliaetus haliaetus** (Linne): There is sight record of *Pandion haliaetus* from Great Nicobar Island by Abdulali (1967, *JBNHS* 64: 156).

p. 65, no. 223 **Falco tinnunculus interstinctus** McClelland, line 3 of text: Biswas's reference is 1976, *JBNHS* 71 : 461.

p. 84, no. 298 **Lophura leucomelana moffitti** (Hachisuka): The wild example of *'moffitti'* referred to has proved to be only an intergrade between *melanota* and *lathami.*

p. 107, no. 438 **Esacus magnirostris magnirostris** (Vieillot): Abdulali (1979, *JBNHS* 75: 745) has reported seeing it in Great Nicobar Island.

p. 115, no. 381 **Charadrius alexandrinus alexandrinus** Linné: It has been recorded from Nicobar Islands by Dasgupta (1976, *JBNHS* 73: 222).

p. 117, no. 386 **Numenius phaeopus variegatus** (Scopoli): Abdulali has reported it from Narcondam Island (1976, *JBNHS* 71: 497) and from Great Nicobar Island (1979, *JBNHS* 75: 755).

p. 118, no. 391 **Limosa lapponica lapponica** (Linné): It has also been reported from Car Nicobar Island by Abdulali (1979, *JBNHS* 75: 767).

p. 124, no. 411 **Scolopax rusticola rusticola** Linné: There is a sight record of this bird from Port Blair, Andaman Islands, by Whitehead (1912, *JBNHS* 21: 1085).

p. 126, no. 414 **Calidris alba** (Pallas) : Abdulali (1979, *JBNHS* 75: 768) has reported it from Car Nicobar Island.

p. 141, no. 478 **Sterna bergii velox** Cretzschmar: There is a sight record of *Sterna bergii* from Great Nicobar Island by Abdulali (1967, *JBNHS* 64: 163).

p. 154. Add no. 527b: **Macropygia rufipennis tiwari** Abdulali (1979, *JBNHS* 75: 757 — Great Nicobar Island).

p. 159, no. 551 **Psittacula alexandri fasciata** (P.L.S. Müller): Biswas (1960, *JBNHS* 57: 536) has discussed about its type-locality.

p. 170. **Surniculus lugubris** has been sighted by Abdulali (1979, *JBNHS* 75: 758-759) in Great Nicobar Island.

p. 184. Add no. 647a: **Ninox affinis rexpimenti** Abdulali (1979, *JBNHS* 75: 760 — Great Nicobar Island).

p. 200, no. 705 **Apus affinis nipalensis** (Hodgson): Biswas (1961, *JBNHS* 58: 119) has restricted its type-locality to Kathmandu, Nepal Valley.

p. 206, no. 727 **Ceyx erithacus erithacus** (Linné): Abdulali (1979, *JBNHS* 75: 761) has recorded it from Great Nicobar Island.

pp. 209-210. Mukherjee & Dasgupta (1973, *Bull. Br. orn. Cl.* 93: 79-81) have resuscitated the genus *Sauropatis* Cabanis & Heine to include the species *Halcyon chloris* (and *H. sanctus,* extralimital).

p. 221, under **Megalaima zeylanica** (Gmelin): The reference of Mukherjee, A. K. (1952) may be deleted, for it pertains to *Megalaima lineata* (Vieillot).

p. 222, after line 7: Add 'Mukherjee, A. K. 1956 (1954), *Rec. Indian Mus.* 52: 162-163'.

p. 222, no. 784 **Megalaima lineata hodgsoni** (Bonaparte): '[sic]' after Bonaparte's name *Megalaimus hodgsoni* should be deleted.

p. 233, line 5: The author's name should be Horsfield.

p. 233, line 10: In the original citation the name appeared as *Picus* (*Chrysonotus* Swainson) *grantia,* and the author was Horsfield.

p. 246, no. 872 **Mirafra javanica cantillans** Blyth: The genus name should be given as *M.(irafra)*. Blyth's reference is dated 1844, and the type-specimen was taken in the vicinity of Calcutta.

p. 246, no. 873 **Mirafra assamica assamica** Horsfield: The species name originally appeared as *Assamica.*

p. 260, no. 926 **Hirundo daurica japonica** Temminck & Schlegel: Abdulali (1979, *JBNHS* 75: 769) observed it in Car Nicobar Island.

p. 280, no. 1002 **Sturnus contra contra** Linné: In the reference cited, Stresemann referred to *Sturnus capensis* Linné, 1766 and *not* to *Sturnus contra* Linné, 1758. Since *Sturnus capensis* Linné is not cited, the reference to Stresemann's work should be deleted.

p. 289, line 10 **Dendrocitta frontalis** Horsfield: 'Nepal' should be deleted, for the bird does not occur there.

p. 317, no. 1146 **Hypsipetes mcclellandi mcclellandi** Horsfield: In the original citation the species name appeared as *McClellandii.*

p. 318, no. 1147 **Hypsipetes flavalus flavalus** (Blyth): Its type-locality has been restricted to Hitaura, Chisapani Garhi district, Nepal by Biswas (1961, *JBNHS* 58: 467).

p. 341, no. 1241 **Paradoxornis nipalensis humii** Sharpe: The name of the author, Sharpe, should be in parentheses.

p. 380, line 14 from bottom, and no. 1399 **Heterophasia gracilis** (McClelland): The author's name should be Horsfield.

p. 385, no. 1412 **Muscicapa parva albicilla** Pallas: Abdulali (1976, *JBNHS* 71: 502) has recorded it from Narcondam Island.

p. 402, no. 1472 **Tesia olivea** (McClelland): McClelland's name was published in 1840 in the issue due in 1839.

p. 412, no. 1507 **Prinia cinereocapilla** (Hodgson), lines 8, 11 and 12: The author should be Moore (not in parentheses).

p. 423, no. 1554 **Acrocephalus orientalis** (Temminck & Schlegel): Abdulali (1979, *JBNHS* 75: 764) has recorded it from Great Nicobar Island.

p. 435, no. 1592 **Phylloscopus inornatus inornatus** (Blyth): It has been recorded from Narcondam Island by Abdulali (1976, *JBNHS* 71: 502). He has also reported sighting it in Car Nicobar Island (1979, *JBNHS* 75: 770), but I do not know how a specimen of this difficult group of leaf warbler was identified up to subspecies through field glasses.

p. 438, no. 1605a **Phylloscopus tenellipes** Swinhoe: Abdulali (1976, *JBNHS* 71: 502) has recorded it from Narcondam Island.

p. 491, no. 1781 **Prunella rubeculoides** (Moore): In the first reference, after Moore 'in Horsfield & Moore' should be added.

p. 521, no. 1883 **Motacilla citreola calcarata** Hodgson: In the original citation the name appeared as *Motacilla* (*Budytes*) *calcarata.*

p. 535, no. 1936 **Zosterops palpebrosa nicobarica** Blyth: Abdulali (1979, *JBNHS* 75: 765) has recorded it from Great Nicobar Island.

p. 562, top: Heading for the species *Carpodacus rhodopeplus* (Vigors) is left out.

p. 594, right hand column, line 6 from bottom: The page numbers should be 110, 111.

Lack of uniformity has been noticed in the style of citation, *e.g.* on p. 158, no. 545 the genus name is given as *P.* [*aleornis*] while in most cases, as on p. 199, no. 698, as *C.* (*ypselus*); and the years of delayed publications as both 1839 (1840) and 1840 (1839) for the same journal.

The casual remark on p. viii 'With the absorbtion of the State of Sikkim, West Bengal may in future include Sikkim' should better have been avoided, for it is liable to create only unpleasantness and misunderstanding.

These comments apart, Dr. Ripley is to be complimented on the way he has revised the text in this new edition so that the book still remains probably the best and most comprehensive of its kind available to ornithologists.

ACKNOWLEDGEMENTS

My grateful thanks are due to Dr. S. Dillon Ripley who kindly read a draft of this paper and offered helpful advice, and to my erstwhile colleague at the Zoological Survey of India, Shri J. M. Dasgupta, for his valuable assistance, specially regarding birds of the Andaman and Nicobar Islands.

BREEDING, DEVELOPMENT AND CULTURE PROSPECTS OF THE HIMALAYAN BARBEL, *SCHIZOTHORAX PLAGIOSTOMUS* HECKEL[1]

S. B. Raizada[2]

Introduction

Schizothoracine represented by the genera *Schizothoraichthys* and *Schizothorax* are an important group of fishes in the cold waters of the Himalaya right from the high reaches of loaches down to water zone little above 20°C temperatures. Though the fish, which gains weight up to 2.5 kilogrammes and 60 cm[3], do not constitute a commercially important group on a national level, they are however in high demand locally in the Himalayan states from Jammu and Kashmir to Arunachal Pradesh. The fish has all the more importance as a fishery of balancing link in the cold waters where the exotic carnivore Salmonids (trouts) have been introduced. The juveniles of the exotic trout find a palatable food in the fish, though the bigger ones also prey upon them equally avidly. Similar dependence is observed in case of Mahseer when living in the higher reaches of its migration limits. Population of Schizothoracine is thus an indicator of the population of trouts and Mahseers in these waters. The fish is of no sporting importance directly[4].

Propagation through culture has not been tried though the relationship with Salmonids and Mahseers is well established. Over-exploitation on unrestricted bag limit besides killing through illegal means including use of explosives and poisoning with plant extracts such as *Artemisia* and *Euphorbia* (Thor) all along the Himalayan belt, particularly the eastern, have reduced the population affecting adversely the fishery. The importance of restoring the population through other than natural means is now gaining importance.

DISTRIBUTION. *Schizothoraichthys esocinus* Heckel and *S. progastus* McClleland are available in the headwaters of the Indus, Ganges and other headwater streams up to Assam. *Schizothorax plagiostomus* Heckel (=*Schizothorax sinuatus* = *Oreinus sinuatus* Heckel, known as *Gulguli* in Hindi, *Asla* in Nepali, and *Mouli* in Lepcha languages), *S. molesworthii* Chaudhri, and *S. richardsonii* Gray are from the subglacial to the subtemperate zones of cold waters in the western, central and eastern Himalaya in that order.

MATERIAL AND METHOD

This study was made on *Schizothorax plagiostomus* of river Beas in the Kulu district of Himachal Pradesh. Work was concentrated on potential spawning grounds in the three tributaries of river Beas, namely Mohal, Sujain and Shirir.

[1] Accepted May 1982.

[2] District Fisheries Officer, P.O. Katrain, Distt. Kulu, H.P. 175 129.

[3] A cast net catch record in river Parbati, a tributary of river Beas, for the Himalayan barbel is 4.2 kg, length 80 cm.

[4] During 18 years of angling with artificial baits, only once have I landed a Himalayan barbel on a golden spinner. That was perhaps a fluke.

Breeding migration, spawning habit, fecundity of wild fish (unpublished works of the author) and development of eggs derived from stripping were observed. Period of work and observation was: 1. January-December, 2. April-June and 3. July-September. Qualitatively the stream selection was made to represent different altitudes that have cold and hot atmospheric environment, and influenced by rain and snow melts.

Hypophysation was tried on broods collected earlier as pre-mature fish and reared in natural ponds making sure of the availability of natural food. Homoplastic freshly collected pituitary in one case, and alcohol preserved in another, was used at dosage mentioned below. Only two trials were made. Females were selected in the weight group 200 to 500 grammes, in stages close to maturation, and males in weight group 200-280 grammes. Two doses at the rate of 5 mg and 2 mg per kg of fish, were given to females at an interval of six hours, and males were injected one dose of 3 or 2 mg per kg only. Care was taken to inject the final dose in the evening as spawning in nature takes place during night.

Stripping was done of mature females and males collected from the snow-fed stream Sujain and the rain-and-snow fed stream Shirir. Weather on both occasions was dry. The first set of females was 200 grammes each and the second set of 400 grammes each in weight. For stripping a female, its belly was first pressed at the centre above ventral fin, thus extruding easy jets of ova, thereafter the belly was taken between the forefinger and thumb and was worked down to ensure complete removal of ova. In the first instance dry method was applied and for the second the wet method. Eggs were retained in sperm solution (milt) for ten minutes, then washed and sorted.

The eggs derived from each female were divided and placed under two different water types every time — one close to the mouth of spring source and the other at an edge of snow-fed channel. Egg trays were wooden — 37×45 cm, lined with 1/16 mesh synthetic screen. The water from the spring had a temperature of 17.5° to 18°C, of pH 7.2, and dissolved oxygen content 5.2 parts per million. Only 1.8% of the eggs hatched, and no young survived up to fry stage. The water from the snow-fed Beas river had a temperature of 12° to 14.5°C, of pH 7.8, and dissolved oxygen concentration 9.5 to 9.8 ppm. 92% of the eggs hatched and 63.8% survived up to fry stage. Eggs of each batch were observed at hours[5] 6 (1/4-0); 24 (1-0); 52(2-0); 76(3-0); 96(4-0); 120(5-0); 192(8-3); 216(9-4); 240 (10-5); 264(11-6); 360(15-10); 504(21-16); 600(25-20); 696(29-24) and 840(35-30). Since the batch kept at spring water perished after 112 hours on both occasions, development stages have been recorded from the second batch under snow-fed water. Eggs were picked at random for observation from the trays.

Observations

General characteristics. Body cylindrical, torpedo shaped, mouth ventral with fleshy adhesive sucker, lower jaw (fringed) for holding on and browsing on the substrate rocks. The male is identifiable from female, having pores on snout, that has a compressed interorbital surface (more so in *S. richardsonii*).

[5] Figures in paranthesis are hours converted into days, shown in order from the day of stripping followed after a hyphen by the days after hatching, e.g. (21-16) is 21 days from stripping and 16 days after hatching.

TABLE 1

QUALITY PARAMETERS OF SPAWNING GROUND STREAMS OF *Schizothorax* IN KULU DISTRICT

Name of stream	Period of observation	Altitude in metres	Source	Temperature in °C	pH	Dissolved oxygen	Colour	Spawning intensity
Mohal	April-May	1220	Snow melt	14.5–18	6.8–7.6	7.4–8.2	Clear	Very heavy
	July-August		Rain	17 –20		7 –7.4	Turbid	—do—
Shirir	April-May	1372	Rain and snow melt	14 –15.5	7 –7.8	8.2	Semi clear	Heavy
	July-August			15 –16		8 –8.5	Turbid	—do—
Sujain	April-May	1525	Snow melt largely	11.5–12	7.8–8.2	9.2–9.5	Clear	Moderately heavy
	July-August			12 –15		9.2	Semi clear	—do—

colour bright grey on dorsal and light pale ventrally. Hydrophyte dominate in the omnivorous feed derived from the stream substrate. Mature female has soft belly and a protruding anal papilla. Ovary runs to complete body cavity lengthwise and occupies approximately 70% of its space when ripe. The eggs when ripe are set free into body cavity to pass to the outside when pressure is brought to bear on the belly. Eggs are whitish, opaque when immature and change to colourless transparent on maturity, particularly after water absorption. Unlike Mahseer, the ovary contains eggs of the same size and stage, indicating spawning in one stage and batch. Total volume of ovary ranged from 45 to 60 cc. in the size group of fishes observed. Fecundity average was 5578 eggs per kilogramme body weight, and number of eggs per gramme of ovary 66.3. Egg diameter ranged from 1.9 to 2.7 mm and a fish of half a kg contained approximately 3000 or more eggs. On an average 10 cc contain 511 eggs without water hardening. Testes are pinkish white containing white, thick, viscous milt; when stripped the fish produces 0.2 to 0.5 cc milt.

Two spawning periods have been identified. The first is mid April to mid June with peak in May, and the second is mid July to mid September with a peak in early August. Fish of the second year group were found mature. Spawning is influenced by the rise in water level of streams, first by snow melt and second by rain when the side streams get flooded. A dry weather during July-August resulted in delayed and subdued spawning. Cloudy weather was not a necessary factor. It was related more to the rise in water level of side streams. Males precede females in the spawning run and

usually flood the site before the females arrive. Spawning takes place at very late hours of the night and most of the spent fishes return to the mother stream before sunrise. There is no excavation of the breeding 'redd' and eggs are deposited in shallow pits and pools 20 to 45 cm deep, of slow currents of 3 to 5 cm per second velocity. (see Table for quality parameters of streams observed for spawning). Spawning was in groups where several males joined in splashing and churning to mix milt in the water. Majority of eggs, on water hardening, get drained down the river and hatch while shifting in flows. This perhaps meets their oxygen requirements. In the process a large number of eggs perish, yet the stream sides and channels are flooded with hatchlings and fry.

Structure of eggs (fig. 1A & 1B). *Schizothorax* egg is soft, pulpy, small and shrunken when released. Outer egg shell is very thin to the extent that picking with forceps or tweezers causes puncture. Perivitelline space large on the upper side of egg body. Yolk sac with germinal disc protruding into large perivitelline fluid, and the rest occupying the lower space. The germinal side always keeps facing the wider perivitelline space — a phenomenon different from other carp eggs. Egg heavy and demersal.

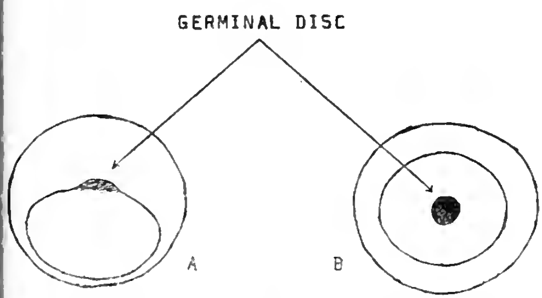

Fig. 1. Egg of *Schizothorax plagiostomus*. A. side view; B. top view.

Water absorption rate is very rapid and egg swells to nearly twice the original size. The osmotic pressure enables the egg to get immediately attached to the substrate more intensely than Salmonid or Mahseer eggs, so much so that the mass of eggs if taken without water turns into a ball of jelly, making eggs in the centre impenetrable to milt. The eggs were freed in a period of three hours on absorbing water.

Hypophysation in both cases resulted in the death of both sexes. In the first instance the females and males died the next morning and in the second the female died the third day morning and male in the evening. On dissection, the eggs found were fully mature but the genital space was not free and the genital papilla hard. The dead males similarly extruded milt on applying pressure to the belly.

During the process of stripping, mixing of milt was difficult in the dry method as the eggs had formed into a mass of jelly at one end of the enamel basin used for stripping. Pressure was applied to the mix but the mass remained in lumps. Next day a large number of eggs were removed dead from the two trays (at spring and snow base). In the wet method milt was collected in 250 cc water in an enamel basin, eggs were stripped over it and more water added later. In both cases care was taken to keep a gap of not more then ten seconds between the time of stripping the female and adding milt. Mixing of egg mass into sperm was easy. Very few eggs had to be removed. Fertilization percentage was 66% and 98.7% from dry and wet methods respectively. Development under the spring source that had more favourable water condition but poor dissolved oxygen had a survival percentage of 45 up to eyeing stage, 1.8 up to hatching, and thereafter all died. In the second case though the eggs were visibly under unfavourable condition, had 92% survival up to eyeing, 86.6%

up to hatching and 63.8% to fry stage. It is evident that high dissolved oxygen was the demand.

Development of egg to fry

6 hours (fig. 2-A). Blastodisc formed at the germinal disc region.

24 hours (fig. 2-B). Embryo formed as a lifted notch over the yolk body without any distinguishing features, though the future head and body side could be identified.

52 hours (fig. 2-C). Embryo elongated, covered half the yolk sphere with identifiable optic lobes; the head facing into perivitelline medium whereas rest of the body passes through lower edge.

76 hours (fig. 2-D). Embryo elongates into a thin cord-like body with a small head on one side and tapering tail on the other side of the now obliterated yolk. Eye spot is visible and vertebral segments marked.

96 hours (fig. 3). The elongated embryo takes shape and size. The future mouth groove is formed, eye well marked without melanophore coloration. A finfold starting from the future anal point, round the tail and backward to the dorsal side, is formed. The head is distinct and the embryo produces occasional twitches.

120, 216 & 240 hours (fig. 4-A & B). At the end of 120 hours the whole lot emerged as alevin from the 'not very active' embryo which had no difficulty to come out of the fissure even if the tail came first, as the egg shell is soft so that it drops away by itself. The emerged alevin lies sideways of a disproportionately large and bulky yellow yolk. Length of alevin is 5.5 to 6 mm. Gill opening visible to the naked eye. At 216 hours the hatchling comes to rest upside occasionally; larval finfold is well defined, running from the future anal point to back and round the tail end and up to the frontal base of future dorsal. Sclerotic ring complete. Air sac appears as a transverse sac that in fact gives buoyancy to the bulky body even at such an early stage. Heart visible as a speck and pectoral appears as a small bud; large eye and 4 gill covers are clear; vertebral column with spines clearly visible. Chromatophore band from snout to

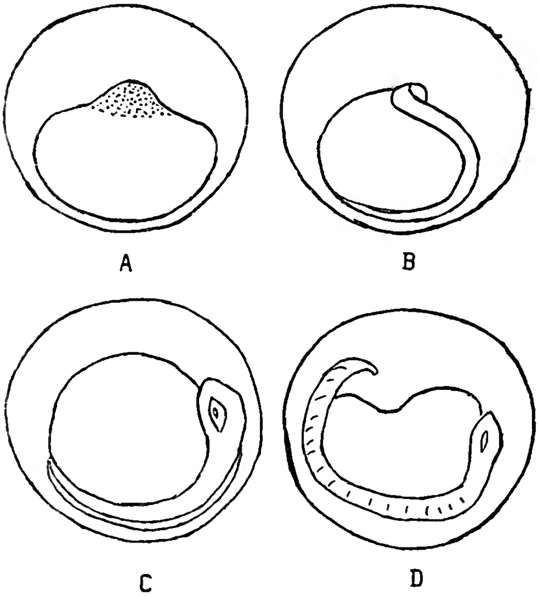

Fig. 2

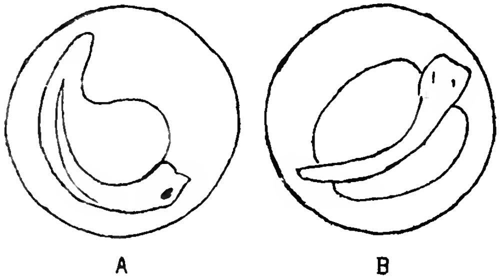

Fig. 3

Fig. 2. Development of egg: A. 6 hours; B. 24 hours; C. 52 hours; D. 76 hours.

Fig. 3. 96 hours: A. side view; B. viewed dorsally.

head, and two other bands run backwards up to the vertebral notch region. The length is 8 mm.

264 hours (fig. 4-C). Two significant appearances are the melanophores around the eye and chromatophores over the head in a trapezoid shape and the rows on either side of the finfold get denser up to the caudal. The heart is prominent, and of a red colour. The air sac enlarges lengthwise. The urostyle is distinct and 7 to 8 rays of the lower caudal lobes are visible. Mouth, lower jaw and gill covers more distinct. Two days later the finfold on the dorsal side gets reduced from a little behind the origin of the future dorsal, leaving a hump of the future dorsal fin, and another finfold appears from anal towards the head in the region of the yolk sac. The anal opening is distinct and the yolk sac fairly reduced. Blood vessels more clear and the hatchling now heads into water current, darts up and down, living gregariously converge in corners; spinal cord and vertebrae with spine rays distinct.

360 hours (fig. 5). The hatchling is 12 mm long. Cranium bone is prominently lifted; readily feeds on phytoplankton. Heart chambers distinct, and so are the blood vessels, especially those leading to the brain. Chromatophore distribution more dense. Eye occupying one third space in the head, starting from snout at a distance half the diameter of length of eye in profile. Melanophore completely cover eye. Gill filament visible, pectoral large, viewed from dorsal it appears as a transparent fan reaching over the heart line. Undivided rays of the dorsal visible; 8 to 9 rays of caudal distinct. The ventral finfold also reduced at a point to identify space for anal fin. Lateral marking clear. Hatchlings now face into the current and dart up and down.

504 hours (fig. 6). The late hatchling is 14 mm long. The eye 0.75 mm diameter, located less than the eye diameter from snout in profile (that in adult is 2 to $2\frac{1}{2}$ diameters from snout). Sclerotic ring transparent that

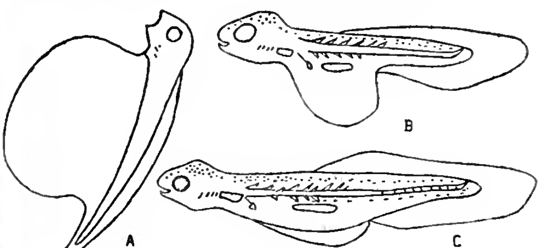

Fig.. 4

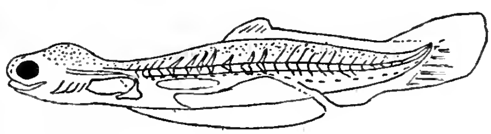

Fig. 5

Fig. 4. A. 216 hours; B. 240 hours; C. 264 hours. Fig. 5. 360 hours.

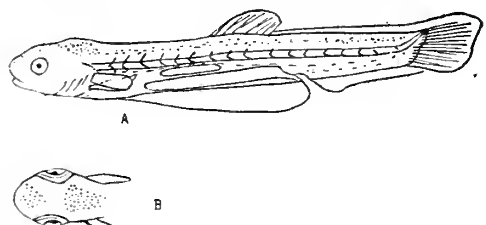

Fig. 6

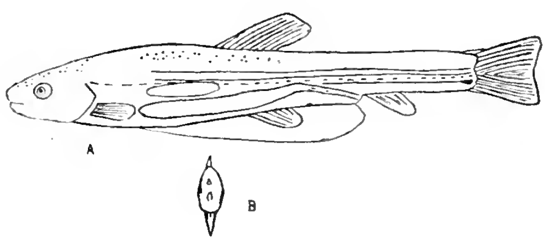

Fig. 7

Fig. 6. 504 hours: A. side view; B. Head viewed from top.

Fig. 7. A. Fry with post larval finfold; B. Cross section of body for position of finfold.

is prominent and a pupil in the centre. A golden iris. Lower lip distinct. Auricle and ventricle of heart identifiable. Oval shaped dorsal with 1+7 fin rays (one osseous). 9 divided rays of the upper lobe of the caudal also appear. Gill cover transparent. Yolk hangs insignificantly.

600 hours. Dorsal embryonic finfold reduced; pair of pelvic fins appears as small specks at mid-region of 264 hours finfold. Anal finfold deepens. The simple trapezoid zone of chromatophores divided into two unevenly triangular sets.

696 hours. Body changes to translucent from the hitherto transparent body. Embryonic finfold dissociated at caudal which is now fully formed of 9+9 rays and is homocercal. Yolk completely absorbed.

35th day. Active fry complete in all respects yet a prominent finfold that had appeared on 264-hour stage at the yolk sac region continues to exist from the region of heart to anal aperture, with a pair of 1.5 mm long ventral fins alongside. Mouth continues to be antero-ventral as against the ventral mouth of adults. Snout having attained a prominent shape, the eye has occupied posterior position at nearly 2 diameter eye distance. A faint triangular blotch appears on the lower part of the caudal base.

Result

It is thus seen that the fish migrate, to spawn into rivulets and creeks some of which are seasonally dry. Like Salmonids the fish can be subjected to stripping and fertilised but the effective method is wet stripping as against the dry one preferred for Salmonids. The reason is clear, namely that the egg shell is thin, perivitelline fluid thick and egg initially shrivelled so that it exerts greater osmotic pressure than a Salmonid egg; thus turning into a heap of eggs in the receiving pan, making the central mass impenetrable to sperm fluid. Any forceful manual effort causes injury resulting in low survival.

Though a higher temperature reduces the hatching period, it is seen that the developing embryo, alevin and the sac fry have high oxygen demand and to meet that even cold turbid water is preferred to a warmer clear spring. In nature the eggs are deposited not under high current but get swept slowly into the current, get lodged under stones where the egg receives oxygen of its requirement. Under the experiment the two batches though kept in identical trays and conditions, the first at the head of spring source with low oxygen and water entirely free of any kind of contamination (the same water further down was used for trout hatching and fry of trout and *Schizothorax* coexist well) had poor hatching result. On the other hand steady development was maintained under the snow. fed, occasionally turbid, colder water of the river, although hatching was faster by 24 hours under spring source.

The post-larval fin membrane (finfold) that developed early, lasts up to a late stage of fry at the region of belly, plays the important role of a keel in balancing the alevin and fry under high currents that the fish has to meet with from the early stage of its life. This is combined with the early development of air sac to make it remain upright within a day or two of hatching. These are an assembly of conveniences that Nature has granted to compensate for early hatching and slow post larval development.

The mouth continues to be antero-ventral as against ventral in adults. The fry has a heavy frontal and lean posterior body. The heavy frontal helps in an easy dive to obtain food from the substrate.

It is also seen that the growth period ratio of larva are inversely related to Salmonid development process. In the later case the alevin emerge at three-fourth the total period of development of egg to fry, whereas in the case of *Schizothorax* the alevins emerge at about one fifth the period and rest of the growth proceeds slowly outside the egg shell. Growth observed after 264 hours under the experiment has been faster in nature due to feeding on abundant natural diet. The homocercal caudal in fact originates from heterocercal development process.

The study also reveals that *Schizothoraichthys* at the approach of summer migrate upstream to spawn, into the smaller tributaries of glacial waters which are too cold, whereas the *Schizothorax* spawn twice, in milder waters once at the approach of summer snow melt and second at the rain rise. The temperature preference of *Schizothorax* is 15° to 17°C. The dissolved oxygen and pH demand is wide though very low limits are damaging and the fish does not live there.

CONCLUSION AND THE PROSPECTS OF CULTURE

The fishery of Trout and Mahseer have a rich source of sustenance in Schizothoracine in open natural waters in the Himalaya. Survival of spawn in nature where these get drained into the turbulent waters is poor. The stripping process mentioned in this paper and the survival obtained artificially (hatchery conditions) is an assurance that the wild stocks can be replenished from farm efforts. Brood can be seasonally obtained from the wild. Farms for the fish would need hatcheries and nursing pits that can be planned at low lying places in temperate and subtemperate zones of the Himalaya, fed from stream rapids. This is important where the Salmonid and Mahseer propagation is planned or already exist. Transportation at egg stage in large quantities is difficult because of the soft quality of egg but the hatchlings after 21 days can be transported, packed in oxygen like other carp fry.

Failure to induce spawn cannot be conclusively described a failure of the method altogether. This can be tried at various other doses for standardisation. However since the fish responded, like Salmonids, to stripping, it is not necessary to depend upon induced breeding.

The large stock in the rheophilic conditions of the mountains would however grow only when the chain of food cycle is maintained to the level demanded. This can be done by restoring river bank vegetative cover, that would stabilise the strata, the algal sheath over stones for a rich diatom population and the chain thereafter.

ACKNOWLEDGEMENTS

I am grateful to many persons in the field, especially the field staff of Fisheries Department in Kulu district of Himachal Pradesh, who helped me to collect ripe stocks and were with me on observation trips at late hours of the night.

ETHOLOGY OF SOME RHYPAROCHROMINES (LYGAEIDAE : HETEROPTERA : INSECTA)[1]

K. THANGAVELU[2]

Feeding behaviour involving 'seed-dragging', 'seed-defence' and 'seed-territoriality'; courtship dance and antennal drumming leading to mating and ovi-position behaviour involving site selection; significance of aposematic and cryptic coloration and mimicry patterns of several common species of Rhyparochrominae are discussed.

INTRODUCTION

Lygaeids exhibit several interesting behavioural patterns like 'seed-defence', courtship dance, stridulation, positive phototaxis, aposematic and cryptic coloration, camouflaging and mimicry. Thangavelu (1979) reviewed the works on the ethology of Lygaeidae and noted that most of the reports were from temperate countries and tropical Africa except for a preliminary study on the feeding and mating behaviour, stridulation, aposematic coloration and ant mimicry of a few Oriental lygaeids (Thangavelu 1978). Hence detailed observations were made on some commonly occurring rhyparochromines by frequent field trips with reference to their feeding, mating and oviposition behaviour; also on their coloration and mimicry patterns. These behavioural patterns were also observed in the laboratory culture.

RESULTS

Feeding behaviour. There are nearly 30 species of Rhyparochrominae commonly found in southern India and of these, except *Clerada* sp., all other rhyparochromines are observed to feed on fallen seeds in the ground litter and are of stylet-sheath feeding type. A few species exhibit some interesting behavioural patterns of 'seed-dragging' and 'seed-defence'. *Poeantius festivus* Dist. carries the fallen seeds of *Acalypha indica* with its labium and moves to a more protected and isolated place and if another *Poeantius* intrudes while feeding, the seed owner shows evidence of excitement and defends by rapidly swinging the antennae back and forth and fluttering the hind legs as if kicking at the ground; if the intruder persists and gets near, the defender spreads its fore and mid legs and attempts to kick the intruder. At this stage, the intruder decamps from the spot; at times the defender runs away from the seed and quickly returns to collect, and run away with the seed; this act often baffles the intruder. *Pachybrachius nigriceps* (Dall.) also exihibits similar protective behaviour; it carries the seeds of *Echinochloa crusgalli* with its labium and at times between the fore tarsi to a considerable disstance; when it senses intrusion, it becomes alert and takes a threatening stance, with the antennae straight and lifted above the head, and the legs well spread; at times it suddenly pounces on the intruder. Seed dragging is also reported in *Horridipamera nietneri*

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(Dohrn) and *Pseudopachybrachius guttus* (Dall.) and the behaviour is more readily seen in a larger colony than among isolated members. *Elasmolomus sordidus* (Fabr.) carries seeds of *Capsicum annuum*, and such collected seeds were found in its habitat. Obviously they had been transported from the harvested fields. The various stages leading to feeding in *Dieuches discoguttatus* (Dist.) are as follows. The bug approaches with the fore legs forward so that the tibiae aids in holding the seed, then the rostrum and the labium protrudes. The tip of the labium pierces the outer surface of the seed coat and if the seed is unsuitable there is no attempt to feed. If suitable, further probing continues; the formation of a salivary sheath followed by the injection of the labium initiates the feeding; the rostrum returns to the venter of the thorax and the labium is thrust deeper and no external digestion is noticed. However, profuse secretion of saliva is noticed when the seeds are fairly large and dry. It is therefore, interpreted that the saliva might dissolve the seed content before pumping through the stylet and also that the salivary fluid might act as a lubricant aiding in penetration of the stylets. It is doubtful, however, whether the hard seed coats of some seeds are dissolved by the salivary secretion. Very dry seeds were not preferred for feeding; when seeds that had been fed on were dissected, damage to the cotyledons was quite obvious. The remnants of the stylet sheath show clear marks of feeding. After feeding, the labium is withdrawn from the seed and the tip is invariably cleaned between the fore-tarsi; the rostrum simultaneously elbows and the labium is inserted in it. *E. sordidus* and *Naphiellus dilutus* (Horv.) were observed to feed in congregation, mostly consisting of first, second and third instars, intensive feeding was observed by such congregations. Only one individual feeds on one seed at any time and the fruits of *Ficus* spp. have a large number of seeds; therefore, this aggregation might be due to the presence of a large number of seeds. Nymphs and adults of *D. discoguttatus* were observed to climb the host plants (*A. indica* and *Lucas aspera*) and feed on the seeds in situ; when disturbed, they fell to the ground and preferred to quickly run away, though they can fly. The femoral teeth were used in climbing on the host plants; all other species were recorded to feed only on fallen seeds. Feeding intensity varies in different species. *E. sordidus, N. dilutus, D. discoguttatus, P. guttus, H. nietneri* often show more intensive feeding than *P. festivus* and *Metochus uniguttatus* (Thun) this agrees with their agility and constantly alert behaviour; also the latter two species are mostly recorded in sparse numbers as isolated individuals, while the intense feeders are often recorded in fairly good numbers in a colony. Intensive feeding in the field is seen during morning and evening hours.

Mating behaviour. In all the species observed, a premating period of 2-3 days was noticed. Mating is invariably initiated by the male. The meeting of opposite sexes is facilitated by sight and neither antennae nor any sex pheromone seem to be involved in bringing together the sexes. But once the opposite sexes encounter each other, antennal rubbing is noticed as part of the courtship. Usually the male recognizes the passing female and walks across: on encounter, the male rapidly waves the antennae; on coming closer to each other, the male holds the fore-tarsus of female with his fore-tarsus, and moves to the lateral side, parallel to the female, and extends the hind legs to lift the genital segments of the female's abdomen. The female, if responding, remains motionless and opens the genital

chamber releasing the ovipositor and immediately the male releases the aedeagus and secures genital connection. Generally the genital connection is achieved from the lateral side or from above the female. After the genital connection is made, the end-to-end copula position is taken up and they remain motionless if undisturbed, otherwise the female drags the male to a secluded place, usually to small crevices or under fallen leaves and wood. The courtship lasts only a few seconds. The copulating pair remains in mating position for a considerable time (2-5 hrs.) if undisturbed. If disturbed during copulation, the female charges the intruder with the antennae and flutters the hind legs; if the intruder persists the female drags away the male to an isolated place. Just mated females never respond to fresh attempts by other males. Such females escape from the attempting males by violent shaking of their bodies, kicking the attempting males and swiftly running away. Mating occurs frequently, 5-8 matings are common in a female during its life. Mating generally occurs at an interval of 3-5 days between copulation, while the males mate quite often. Generally feeding ceases during copulation. The above account concerns *D. discoguttatus*. A more or less similar behaviour is noticed in *E. sordidus* and *N. dilutus* also. *P. festivus* at times suddenly jumps on to the female and secures genital connection from above the female. In this species courtship involves repeated drumming of the female by the male with the antennae and mating lasts only 30-60 minutes. *M. uniguttatus* has a quite interesting mating behaviour. On encountering the female, the male detains the female and touches the head of the female with the antennae, and the female responds similarly by touching the head of the male; then the fore legs on one side are inter-locked; in this position, they do a kind of shaking dance. The mating lasts 1-3 hrs. in *M. uniguttatus* and 2-3 hrs in *E. sordidus* and *N. dilutus*. The post-copulatory behaviour is also interesting; after mating, the male and the female separate and walk in different directions in *E. sordidus* and *N. dilutus*. *D. discoguttatus* detains the female for a few seconds and then they leave. Before moving from the copulation site, both the male and the female clean their genital segments with the hind-tarsi. Mating in field condition is intense during 10.00-12.00 hrs in most of these species; however, in the insectaries they mate throughout the day and more frequently during evening hours (18.00-20.00 hrs).

Oviposition behaviour. Oviposition starts 1-3 days after mating; all the species lay eggs in the litter, rarely on fallen fruits of *Ficus* and twigs. The females of *E. sordidus* select moist places for oviposition. The ovipositing female moves away, selects a suitable site and releases her ovipositor by sideways movements of the terminal segments of the abdomen; the ovipositor is thrust in the sand and debris of the litter, where the eggs are deposited. Before the release of eggs, the abdomen is straightened and then flexed downwards in a rhythmic rocking motion several times, the ovipositor then moves sideways and the egg is finally deposited. Along with the ovipositor, the terminal segments of the abdomen also enters the debris while inserting the eggs. During oviposition, all the three pairs of legs are well spread and tarsi are firmly planted onto the substratum giving a firm grip for the insect; the fore and mid legs are drawn anteriorly while the hind legs are drawn posteriorly; the antennae are flexed backward against the head, almost parallel to the body. Before the eggs are laid, they are held in the ovipositor for one or two seconds. It takes 15-20 seconds

for the first egg to be laid and the subsequent eggs are laid in 8-12 seconds. Immediately after laying the eggs, the ovipositor is withdrawn and the posterior segments of the abdomen contract sideways twice or thrice and then the next egg is laid. *E. sordidus* lays eggs in small clusters of 3, 5, 7, 9 and less frequently, single eggs are scattered and the egg clusters are cemented together by a secretion of the female; in the field the sand and debris adhere to the egg surface. When field condition is created in the laboratory, they prefer to lay eggs in sand and among twigs, otherwise they readily oviposit on wet cotton wool, which is preferred to dry cotton wool; at times they oviposit in the crevices of the rubber stopper, cork, muslin cloth, but the smooth surfaces of the rearing glass jars are never preferred. Mostly the eggs are laid horizontally in the long axis; when clusters of eggs are laid, they are haphazard. The largest cluster of eggs laid, by a single female in one day had 17 eggs. 15-30 minutes prior to commencement of oviposition, the female suspends feeding and moves about searching for a suitable site. Immediately after oviposition, the female cleans the ovipositor with the hind legs and then the ovipositor is retracted into the abdomen; at times it kicks the ground, spreading the sand and dust particles on the egg surface and feeding commences immediately after oviposition. Oviposition is noticed in the field at dusk, after 18.00 hrs. In the laboratory, the oviposition is noticed during 20.00 hrs to 04.00 hrs. The same behaviour is true of *N. dilutus, M. uniguttatus* and *D. discoguttatus, P. festivus* always lays fewer eggs, generally single eggs, and they are scattered. Cleaning of ovipositor is not seen in this species.

Protective coloration and mimicry. The adults of *E. sordidus, E. lineosus,* and *N. dilutus* are sandy coloured with one or more black spots on the corium of the forewing which match extremely well with the environmental background, this cryptic coloration deceives predators. *Plinthisus* spp. which are found deep in the litter are dark brown similar to the fallen dry leaves and twigs. The cryptic coloration in the adults of *P. guttus* and *H. nietneri* is already on record (Malipatil 1979). First instars of these species and *P. festivus, D. discoguttatus* and *M. uniguttatus* are aposematic, bright red and have a greater survival value; the later instars are black, yellow and white spotted or speckled giving them cryptic coloration. Several rhyparochromines mimic the ants in their coloration as well as in their habitat and behaviour. The adults of *P. festivus* are excellent ant-mimitic forms; most of them are brachypterous (85%) while macropterism is not uncommon (15%). Bergroth (1921) indicates that macropterous forms would be less ant-like and hence selected against and more easily recognized as foreign animals by the ants. Similarly the species of the genera *Dieuches, Metochus, Pachybrachius* and *Horridipamera* are also ant-mimitic. Species of *Dieuches* and *Metochus* are generally black, linear and elongate in body form and the appendages like antennae and legs are very long and slender; the wings have spots of white and yellow like maculae, more resembling the abdominal constriction of the hymenopterous insects and mimic the camponotine ants. Species of *Pachybrachius* and *Horridipamera* are also black in general appearance but have extremely swollen prothorax similar to the ants. In general the various members of Rhyparochromini and Myodochini have unusually long appendages similar to the ants which they mimic. These species also mimic their model in their behaviour. *D. discoguttatus* moves fast; while walking or

running, it constantly taps the ground with its antennae; if excited, it runs fast with great agility. *P. festivus* is generally seen running; on its way, it abruptly stops and turns suddenly in another direction like the fast moving ants. *M. uniguttatus* frequently lift the fore legs and rub the fore tarsi against each other. Species of *Pachybrachius, Pseudopachybrachius* and *Horridipamera* run helter-skelter if disturbed, which have selective advantage against a predator, as this behaviour and cryptic coloration baffles the predator and even the insect collector (the investigator himself). They make the mimicry much more effective by their constant association with ants; often sharing their habitat. But in their association with the ants, they are not recorded to be predatory on the ants, nor as entering the ant-hill as reported by Bergroth (1921). The association of these bugs with ants has been thus found to be of survival value since they are not easily attacked by their predators.

Discussion

The several interesting aspects of feeding behaviour involving, 'seed-dragging', 'seed-defence' and 'seed-territoriality' as reported by Sweet (1964) and Malipatil (1979) appear to have no significance except that they might be useful to avoid competition. As stated earlier all the seed feeders are of stylet-sheath feeding type as Sweet (1964) had reported earlier. Miles (1968) reported 'stylet-sheath to be a characteristic feature not of the phytophagous bugs but of the Homoptera and the pentatomomorpha, whether phytophagous or not and he doubted the exception cited by Schmidt (1959). Of the other behavioural phenomena it is particularly worthwhile to observe *D. discoguttatus* often touching the ground with its long antennae while walking or running and running with great agility when excited. A similar behaviour was reported in *Ozophora picturata* (Sweet 1964). Species like *E. sordidus, M. uniguttatus,* and *P. nigriceps* run swiftly when disturbed and hide under fallen leaves and stones or in crevices.

Another striking feature is the prevalence of aposematic and cryptic coloration among the various species. The earlier instars of *E. sordidus, N. dilutus, L. singalensis,* and *D. discoguttatus* are bright red and they are also gregarious. This aposematic coloration and gregarious habit might provide them a better survival value. Sexton, Hoger and Ortleb (1966) suggest that the aggregation of the nymphs of *Oncopeltus fasciatus* (Dall.) makes their aposematic coloration more effective. Lygaeids generally are 'sombre' or 'dull' coloured. Species like *E. sordidus, N. dilutus* and *E. lineosus* are earth-brown and match excellently with the background of the environment, which provides concealment.

The culmination of the several morphological adaptations and behavioural patterns is found in the ant-mimitic feature of some of these rhyparochromines. As previously stated, they mimic the ants not merely in their morphological features; but also behave like them. Thus the constant association and the behavioural pattern make the mimicry more perfect than mere coloration or swollen thoracic segments or maculae in the forewings and long segments. Sweet (1964) could not assign the mimicry pattern of the rhyparochromines either to Batesian or Mullerian types and therefore suggested a combined Batesian-Mullerian type. Remold (1962) assumed that the rhyparochromines may be distasteful because of their scent glands and therefore assumed Mullerian mimicry. Sweet (1964) could not accept Batesian mimicry because of the abundance levels when compared to the ants, which would help a

bird predator to distinguish them. But as far as the south Indian forms are concerned, the ants are also equally abundant. Further, the adults in which the scent gland secretion is not as much as in the nymphs also mimic the ants therefore, if they are of Mullerian mimitic type, the adults should be under selection pressure and preyed on more commonly than the nymphs. During the study it was found that there is no difference between the nymph and the adult as far as predation is concerned; therefore, it can only be of Batesian type. However, it is certain that cumulative effects of cryptic and aposematic coloration and mimicry render a better survival value to these rhyparochromines.

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AN INTERESTING COLLECTION OF AMPHIBIANS AND REPTILES FROM CHOLISTAN DESERT, PUNJAB, PAKISTAN[1]

M. S. KHAN[2]

This report is based on a collection of 60 amphibians and reptiles made from Northern Cholistan Desert, Punjab, Pakistan. The collection includes new records for the area *Rana breviceps* and *Spalerosophis arenarius,* and validate taxa *Natrix sancti-johannis* and *Bungarus sindanus*. Moreover, it throws light on the importance of Cholistan Desert as a zoogeographical barrier between Oriental and Palaearctic Regions.

In summer 1980, I had a chance to tour northern Cholistan Desert and make a small (60 specimens) but interesting collection of amphibians and reptiles. Information pertaining to the herpetology of this area is scanty. However, recently our knowledge about the herpetology of Pakistan has been furthered by the works of Minton (1962, 1966) and Mertens (1969). These concern the herpetology of the Lower Indus Valley and Baluchistan. Other works pertaining to nearby area are Blanford (1879) and Loveridge (1959) dealing with herpetofauna of Rajputana, Bahawalpur, and Thar Parker.

Geography of Cholistan Desert

Cholistan is the south-eastern desert of Pakistan, spread over an area of about 27,800 sq. km in the districts of Bahawalpur, Bahawalnagar, Khairpur and the greater part of Thar Parker. It lies between latitude 24°52′ and 29°45′ North and longitude 69°52′ and 73°5′ East.

The topography of Cholistan is divided into southern Greater Cholistan and north-western Lesser Cholistan. This collection is from Lesser Cholistan, which includes desert margins, with undulating to rolling dunes and inter-dunal depressions of sand and loam of light grey colour. The collections were made from Dahranwala, Chak 141 Murad, Chistian, Fort Abbas, Haroon Abad, Fort Mroat in Bahawalnagar District; Chak 190 Murad and Bakshan Khan in Bahawalpur District. The land in these districts is being rapidly reclaimed and dunes are being bulldozed, destroying natural land form, fauna and flora. Two canals, Fordwah, and Sadquia from Sulaimanki Headworks, ramify throughout the districts.

The climate is arid, tropical and continental with a mean truly erratic annual rainfall of 100 to 200 mm and mean minimum temperature of the coldest months is — 2.2°C and maximum of the hottest months 49.7°C (Beig *et al.* 1979).

Habitations are extremely scattered and small sized. Economy is mainly pastoral, large herds of camel, cattle, sheep and goats graze the area. At spots near Indo-Pak border, brackish water occurs at a depth of 30 to 90 metres, with salt content 9000 to 24000 ppm. However, sweet water is also available at many places at shallow depths, making cultivation possible.

[1] Accepted August 1983.
[2] Herp. Laboratory, 15/6 Darul Saddar North, Rabwah, Pakistan.

Natural vegetation of Cholistan is of typically xerophytic in character and has trees, shrubs, grasses and forbs.

TREES. *Prosopis spicigera, Tamarix articulata, Capparis decidua.*

SHRUBS. *Zizyphus nummularia, Calligonum polygonoides, Haloxylon salicornicum, Aerua javanica, Calotropis gigantea, Tamarix gallica, Alhagi camelorum, Salsola foetida.*

GRASSES. *Lasiurus hirsutus, Aristida depressa, Cymbopogon jwarancusa. Cenchrus ciliaris, Saccharum munja.*

FORBS. *Citrullus colosynthis, Dipterygium glaucum, Crotalaria burhia, Corchorus depressus* and *Tribulus terrestris.*

SYSTEMATIC ACCOUNT OF SPECIES

AMPHIBIANS

Family BUFONIDAE

Bufo stomaticus Lütken

Material collected. Dharanwala (5), Haroon Abad (3), Fort Abbas (4), Fort Mroat (3), (number in parenthesis indicates number of specimens collected).

Taxonomic remarks. Snout-vent length 52-61 mm, females larger. Males have longer hind limbs reaching to shoulders, while females have short, reaching to elbow. Tarsal ridge feebly (3 specimens) or prominently (12) indicated. Males less wartier than females. Nuptial excrescences in male on the inner side of 1, 2, and 3rd finger and inner carpel tubercle. Distinct transverse stripes on brachium and antibrachium, in both sexes.

Family RANIDAE

Rana breviceps Schneider

Material collected. 141 Murad (1), three males were spotted calling alongwith *B. stomaticus,* and *Rana tigerina,* in the shallows of a water course. Two escaped in the thick grass.

Taxonomic remarks. Snout-vent length 75 mm, body slender than those of Alpine Punjab (Khan 1979). No sub-tibiotarsal tubercle as noticed by Leviton *et al.* (1956) and Bhaduri and Kirpalani (1954) in the material from southern India.

This report is the first record from Cholistan Desert for this frog. However, it has been reported from desert areas in the lower Indus Basin (Minton 1966). Apparently, present collection is due to Sutlej River and its canals, irrigating the area. Similar riverine distribution for the species has been demonstrated for the Ravi River (Khan in Mirza and Ali 1972) and the Chenab River (Khan 1968).

Rana cyanophlyctis Schneider

Material collected. Chak 141 Murad (4), Fort Mroat (3), Haroon Abad (1).

Rana tigerina Daudin

Material collected. Chak 141 Murad (1), Dahranwala (1).

Specimens are typical *t. tigerina,* but are slimmer than those of alpine Punjab.

LIZARDS

Family GEKKONIDAE

Hemidactylus leschenaulti Dumeril and Bibron

Material collected. Daharanwala (1), Chak 141 Murad (4), Fort Mroat (1).

Taxonomic remarks. Snout-vent length males 46-49, females 52-56; upper labials 9-10, lower labials 7-9; preano-femoral pores 20-26 in males, in females absent; lamellae under fourth toe 10-12.

Specimens were collected from inhabited houses, during night, feeding on photophylic insects.

Stenodactylus orientalis Blanford

Material collected. Chak 141 Murad (4), Fort Mroat (1).

Taxonomic remarks. Females longer (50 mm) than males (46 mm); however females have shorter tails (35 mm) than males (37 mm); upper labials 10-12, lower labials 9-11.

Ground geckos, active from sunset to dawn. Very agile on loose sand, while running throw up sand. When handled twitch tail and faint squeaks are given.

Family SCINCIDAE
Mabuya dissimilis (Hallowell)

Material collected. Chak 141 Murad (2).

Taxonomic remarks. Two mid-dorsal scale rows bicarinate, rest tricarinate.

Inhabits reclaimed areas, frequenting grass fields. Very agile. The specimens were caught from under the light of a lamp, apparently, attracted by the photophylic insects. They perhaps avoid the intense day heat, and were active during night.

Family AGAMIDAE
Agama sp.

A large agama of the size of about 170 mm, with flat body, crept into a burrow at the roots of a dry *Alhagi camelorum* bush. The dorsum of the body had a row of 3 large dark and white ocelli, in mid-dorsal body. All efforts to extract it failed, due to the failing light and loose sand. Most probably it was *Agama minor,* reported from Jhang District, Punjab, Pakistan by Khan (1972).

Family LACERTIDAE

Acanthodactylus cantoris cantoris Günther

Material collected. Chistian (2), Fort Abbas (3), Fort Mroat (3), Chak 141 Murad (2), Bakhshan Khan (1).

Taxonomic remarks. Females longer (79 mm) than males (68 mm); supralabials 7-9, infralabials 6-9; wide range of variation in number of supralabials in contact with large suboculars: 3, 4, 5th in contact (in three specimens); 4, 5, 6 on right side while 4, 5, 6 on left (1); 5, 6 on left, while 4, 5, 6 on right (1); on both sides 4, 5, 6, 7, and 8 (2). Ventrals in 10-13 rows; femoral pores in males and females 35-43.

Adults of both sexes with a dark reticulum on light grey dorsum, tail tip blue. Juveniles of S. V. length of 26-29 mm with 7-8 dark longitudinal stripes on the body dorsum.

Family VARANIDAE
Varanus bengalensis (Daudin)

A large varanid with distinct double keel on tail, was seen on roadside, near Fort Mroat Town. It quickly went down a burrow at the root of a thorny bush.

SNAKES
Family COLUBRIDAE
Natrix sancti-johannis Boulenger

Material collected. Fort Mroat (2), Bakshan Khan (1).

Taxonomic remarks. Ventrals 149-158, subcaudals 85-88; mid body scale rows 18-19 supralabials 9, infralabials 10; there is no oculo-supralabial dark stripes, validating the taxon *sancti-johannis* (Khan 1984 a). The present report is the first of this snake from Pakistan.

Psammophis schokari (Forskal)

Material collected. Fort Mroat (1), Chak 190 Murad.

Taxonomic remarks. Ventrals 186-187, tails in both damaged; mid body scale rows 17. Specimen from Chak 190 Murad has no lineate design like that from Fort Mroat.

This snake is typical of the dunes, and is very agile on loose sand. It is called "Tir Mar" or arrow snake by local people, as it moves with considerable speed on sand.

Spalerosophis arenarius (Boulenger)

Material collected. Fort Mroat (1), Chak 141 Murad (1).

Taxonomic remarks. Ventrals 238 and 245; subcaudals 82 and 90; mid body scale rows 25; supralabials 11, infralabials 12/11, 11/12; temporals 4, 4.

Differs from material reported by Smith (1943), in having higher ventral and subcaudal counts. However, except for the higher subcaudal counts, scutellation falls within the range of material reported from Sind (Mertens 1969) and southern Baluchistan (Minton 1966).

This is the first report of the Red Spotted Diadem snake from Punjab, Pakistan.

Family ELAPIDAE

Bungarus sindanus Boulenger

Material collected. Chak 141 Murad (1), Chak 190 Murad (1).

Taxonomic remarks. The Kraits are clearly distinct from *B. caeruleus* because of their higher scutellation.

	Midbody scale rows	Ventrals	Sub-caudals
Minton (1966)	15	205-216	43-54
Mertens (1969)	15	202-214	40-55
Present collection	17	223-232	51-59

Naja naja naja (Linnaeus)

Material collected. Bakshan Khan (1).

Taxonomic remarks. Male, ventrals 188, subcaudals 67; scale rows at hood 24, mid body 21; a cuneate scale between 4th and 5th infralabial; posterior genial long and narrow, unlike as in Smith (1943) where anterior is long.

No dark stripes at the ventrals on the ventrum of hood, unlike the material reported from Pakistan (Minton 1966, Mertens 1969, and Khan 1977 and 1982).

ZOOGEOGRAPHICAL IMPORTANCE OF CHOLISTAN DESERT

The Cholistan Desert demarcates humid and mesic Ganges Basin from dry and arid Indus Basin. Undulating sand dunes, general absence of vegetation, high temperature and prevailing xeric conditions not only make it impassable for Oriental forms but also for highland Palaearctic forms. Recently, due to the elaborate canal systems and gradual reclamation of lower and upper Indus Valley, environmental conditions have changed. However, the Cholistan zoogeographical barrier does not allow free East-West flow of species, for which the Mekran coast was the route in the past.

Many Cholistan-o-Sindian elements do not cross into Pakistani Punjab on the West, similarly into India in the East. On the West, the Sutlej River forms the boundary. Forms confined to the Cholistan Desert are *Stenodactylus orientalis, Psammophis schokari, Spalerosophis arenarius* and *Bungarus sindanus.*

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NEW DESCRIPTIONS

EULOPHID PARASITES (HYMENOPTERA: EULOPHIDAE) OF AGROMYZIDAE IN INDIA[1]

M. A. KHAN[2]

(With fifty six text-figures)

Additional generic characters of mandibles, maxillary and labial palpi, subgenital plate and external female genitalia are proposed for the genera *Diglyphus* Walker, *Hemiptarsenus* Westwood, *Pediobius* Walker and *Euderus* Haliday. One known species of *Euderus* (*E. agromyzae* Gangrade) and five new species (*D. horticola* sp. nov., *D. mandibularis* sp. nov., *D. funicularis* sp. nov., *Hemiptarsenus indicus* sp. nov., and *Pediobius indicus* sp. nov.) are described in detail, Key to the Asiatic species of *Diglyphus* is also provided. Type material is being deposited in Zoological Survey of India, Calcutta, India.

Genus **Diglyphus** Walker

Diglyphus Walker, 1844. *Ann. Mag. Nat. Hist.* 14:409.

Type species *Cirrospilus chabrias* Walker 1838 Monotypic.

The distinguishing characters of the genus have been given in detail by Peck *et al.* (1964) and Gordh and Hendrickson Jr. (1979). Some new generic characters are suggested which will further facilitate the identification of this genus from closely allied ones, *viz.* mandibles quadri to pentadentate (Fig. 2), maxillary (Fig. 3) and labial palp (Fig. 4) two and one segmented respectively, subgenital plate (Fig. 12) deeply concave, middle of anterior margin connected with the central notch of posterior margin by longitudinal groove, first valvifer (Fig. 13) triangular, outer plate (Fig. 13) of ovipositor narrow at base gradually widening posteriorly with a submarginal ridge along one half length of dorsal margin, third valvulae short (Fig. 13), conical.

The genus is recorded for the first time from India.

KEY TO THE ASIATIC SPECIES OF THE GENUS *Diglyphus* WALKER

1. Forewings hyaline........................2
— Forewings infuscated 6
2. Funicle segments longer than broad........3
— Funicle segments greatly transverse except first which is quadrate, scape entirely pale yellow, pedicel and flagellum blackish; notauli always complete. extending parallel towards transscutal suture; trochanter, femora and tibiae uniformly pale nearly white. ..... *D. albiscapus* (Girault)
3. Entire tibiae predominantly metallic coloured 4
— Entire hind tibiae pale yellow or with faint to dark brown bands 5
4. Forewing narrow. uniformly densely haired from basal vein to apex, basal cell open below or closed distally: cubitus strongly sinuate upwards ....*D. isae* (Walker)
— Forewing broader with a speculum or at least a narrow less densely haired strip just beyond basal vein; cubitus hardly sinuate: funicle segment atleast 1.5 times as long as broad. ....*D. minoeus* (Walker)

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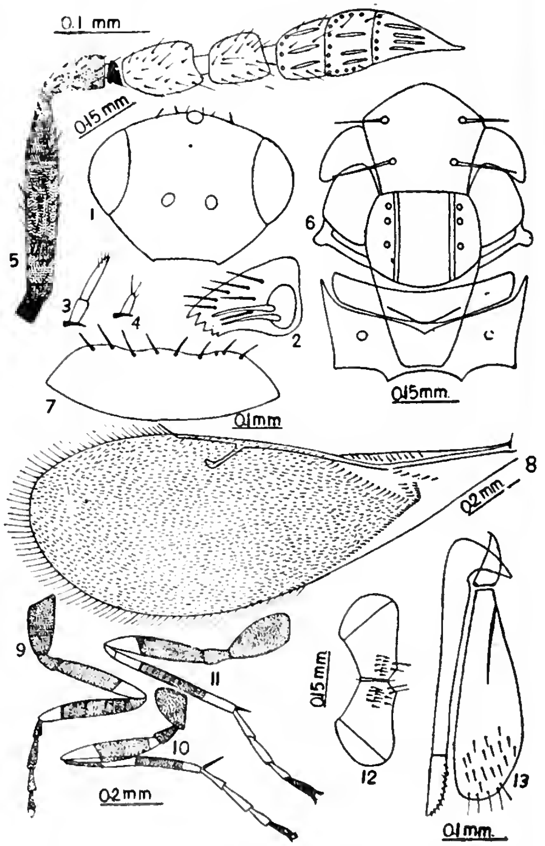
5. Mandible quadridentate; thorax green with scutellum purplish; hind tibiae pale yellow without any brown band; marginal cilia long, in smaller specimen nearly as long as stigmal vein, postmarginal vein small. ....*D. pusztensis* (Erdos & Novicky)
— Mandible pentadentate, thorax dark brown with golden reflections, hind legs with a large dark band in the middle; post marginal vein very long, stigmal vein half the length of postmarginal vein, marginal fringe short. ....*D. horticola* sp. nov.
6. Entire club white, funicle segments quadrate, subequal in size; stigmal vein longer than post marginal vein.........*D. mandibularis* sp. nov.
— Entire club uniformly brown except apex white, funicle segments longer than wide, postmarginal vein longer than stigmal vein. ....*D. funicularis* sp. nov.

Diglyphus horticola sp. nov.
(Figs. 1-13)

FEMALE: *Head* (Fig. 1). Dark brown with golden reflection, wider than long in facial view (0.44: 0.35), width of frons between eyes more than half the head width; frontovertex wide, wider than long; ocelli arranged in obtuse angle triangle; antennae inserted well above the lower level of eyes; distance between two antennal sockets less than their distance from eye rim (0.06: 0.08); mandibles (Fig. 2) pentadentate, the three outer teeth well developed, long with sharp apices, the inner two short and saw-like; maxillary (Fig. 3) and labial palp (Fig. 4) two and one segmented respectively.

Antennae (Fig. 5). Dark brown with funicle segments and club white; scape cylindrical, six times longer than wide (0.21: 0.035); pedicel long, twice as long as wide (0.07: 0.035), shorter than preceding first funicle segment, two anelli intervening between pedicel and first funicle segment; first funicle segment (0.08: 0.06) distinctly longer than second segment (0.065: 0.055); club three segmented, three times longer than wide (0.2: 0.069), shorter than funicle and pedicel combined; first funicle to last club segment with 9, 7, 6, 5 & 4 sensoria respectively.

Thorax (Fig. 6). Dark brownish with golden reflections, with fine reticulate sculpture; posterior margin of pronotum (Fig. 7) with 8 setae; scutum wider than long (0.26: 0.25) with four long, strong bristle, parapsidal furrows weak; scutellum (0.25: 0.21) shorter than scutum with six long, strong bristles, propodaeum highly carinated.



Figs. 1-13. *Diglyphus horticola* sp. nov., ♀. 1. Head, frontal aspect; 2. Mandible; 3. Maxillary palp; 4. Labial palp; 5. Antenna; 6. Thorax, dorsal aspect; 7. Pronotum; 8. Forewing; 9. Fore leg; 10. Middle leg; 11. Hind leg; 12. Subgenital plate; 13 Ovipositor.

Fore Wings (Fig. 8). Hyaline, densely setose, more than two and a half times longer than wide; submarginal vein long (0.5), with six strong setae, marginal vein (0.31) distinctly longer than postmarginal vein (0.2), stigmal vein (0.12) less than half the length of postmarginal vein; costal cell narrow, with 10 setae; marginal fringe short.

Hind Wings. Hyaline, less than five times longer than wide; apex of marginal vein with three curved hooklets; marginal fringe long.

Forelegs (Fig. 9). Coxa, trochanter and femora except apical $\frac{1}{4}$ dark brown, apical $\frac{1}{4}$ of femora and basal tip of tibiae whitish, rest of the tibiae yellowish brownish with faint brown patches on basal half and on apical half; tarsal segments yellowish brown.

Middle legs (Fig. 10). Coxa, trochanter and femora except basal tip and apical $\frac{1}{4}$ dark brown, rest of the leg yellowish with dark brown bands on basal half and on apical half of tibiae, last tarsal segments brownish.

Hind legs (Fig. 11). Coloration same as of middle legs.

Abdomen. Dark brownish, longer than thorax; subgenital plate deeply concave (Fig. 12), middle of anterior margin connected with central notch of posterior margin by longitudinal groove; first valvifer triangular (Fig. 13) with articular knobs prominent, second valvifer long with thickened dorsal margin through out; third valvulae short (Fig. 13) moveably articulated with second valvifer, outer plates of ovipositor (Fig. 13) narrow at base, broad at apex, basal $\frac{3}{4}$ with thickened dorsal margin and a ridge in the middle, ovipositor slightly exserted.

Length of female, 1.4 mm.

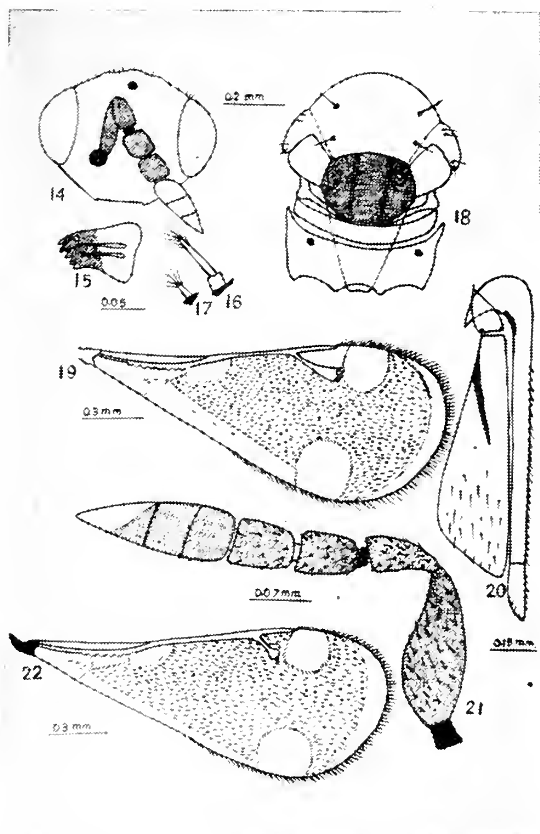
MALE. Not known.

Holotype. ♀ INDIA, Pantnagar, *ex* pea leaf miner, *Chromatomyia horticola* (Diptera: Agromyzidae) on field peas, *Pisum sativum* L. 3-1-1979 (M.A. Khan) Hym. Eulo. Nr. 1005 (M. A. Khan).

Paratype. 60 ♀♀ (Same data as holotype) Hym. Eulo. Nr. 1006 (M. A. Khan).

Diglyphus mandibularis sp. nov.
(Figs. 14-20)

FEMALE. Head (Fig. 14). Dark metallic with bluish green reflections; frontovertex wide; ocelli arranged in acute angle triangle, basal



Figs. 14-20. *Diglyphus mandibularis* sp. nov., ♀. 14. Head, frontal aspect with antenna; 15. Mandible; 16. Maxillary palp; 17. Labial palp; 18. Thorax, dorsal aspect; 19. Forewing; 20. Ovipositor. Figs. 21-22. *Diglyphus funicularis* sp. nov., ♀. 21. Antenna; 22. Fore wing.

ocelli about twice its diameter from eye rim; subocular suture distinct; mandibles with apical half reddish (Fig. 15).

Antennae (Fig. 14). Uniformly brown except club white; pedicel twice as long as white (0.09 : 0.045), funicle segments quadrate, subequal (0.081 : 0.081), club three times longer than wide (0.21 : 0.06).

Thorax (Fig. 18). Dark brown with bluish green reflections on the dorsum, scutellum with fine reticulations, surface of propodaeum shagreened, weakly sculptured, spiracles separated from anterior propodael margin by a space equal to diameter of spiracle.

Forewings (Fig. 19). Infuscated with five contrasting hyaline areas, namely proximal part of basal triangle, a small oval area beneath apex of submarginal vein, two large areas beyond venations and an apical hyaline area; wings almost two and a half times as long as wide; submarginal vein with six setae, costal cell rather broad, marginal vein shorter than submarginal vein, stigmal vein longer than post-marginal vein.

Legs. Coxa dark brown, femora, tibiae brown with greenish reflections, tarsal segments white.

Abdomen. Dark metallic with shining bluish green reflections on the dorsum, as long as thorax.

Length of female. 1.52 mm.

MALE. Not known.

Holotype. ♀. INDIA, Nainital, Jeolikot (4000 ft) *ex Melangromyza obtusa* on *Flemingia* sp. 6-11-1979 (Hym. Eulo. Nr. 1007) (M. A. Khan).

Paratype. 18 ♀♀. Same data as holotype (Hym. Eulo. Nr. 1008 (M. A. Khan).

Diglyphus funicularis sp. nov.
(Figs. 21-22)

Resembles *Diglyphus mandibularis* sp. nov. except in the following characters.

Antennae (Fig. 21). Uniformly brown except apex of club white, scape dilated, distinctly less than three times longer than wide, pedicel twice longer than wide (0.09 : 0.04), distinctly longer than first funicle segment, funicle segments longer than wide, subequal in size (0.065 : 0.05), club distinctly less than three times longer than wide (0.16 : 0.065), longer than funicle.

Forewing (Fig. 22). Almost twice as long as wide, submarginal vein with 8 setae, postmarginal vein longer than stigmal vein (0.025 : 0.019).

Length of female. 1.5 mm.

MALE. Not known.

Holotype. ♀. INDIA, Nainital. Jeolikot (4000 ft) ex *Melangromyza obtusa* on *Flemigia* sp. 6-11-1979 (Hym. Eulo. Nr. 1009) (M. A. Khan).

Paratype. 6 ♀♀. Same data as holotype Hym. Eulo. Nr. 1010 (M. A. Khan).

Hemiptarsenus Westwood

Hemiptarsenus Westwood, 1833, Mag. Nat. Hist. 6: 122.

Type Species. *Hemiptarsenus fulvicollis*

The genus *Hemiptarsenus* Westwood can be separated from other genera in having parapsidal grooves (Fig. 28) incomplete or only faintly indicated in posterior third, antennae with four funicle segments, segments elongated (Fig. 27), male antennae with three long branches.

In addition some new generic characters are suggested which will further facilitate the identification of this genus from closely allied ones, *viz.* mandibles (Fig. 24), quadridentate with very sharp apices, maxillary (Fig. 25) and labial palp (Fig. 26) with two and one segmented respectively; subgenital plate (Fig. 31) with anterior margin cone like in the middle, posterior margin with a deep notch in the centre, first valvifer (Fig. 32) triangular with

articular knobs prominent, third valvulae (Fig. 33) short, lanceolate, outer plate of ovipositor (Fig. 33) narrow at base, rounded at apex, dorsal margin thickened with a ridge in the middle.

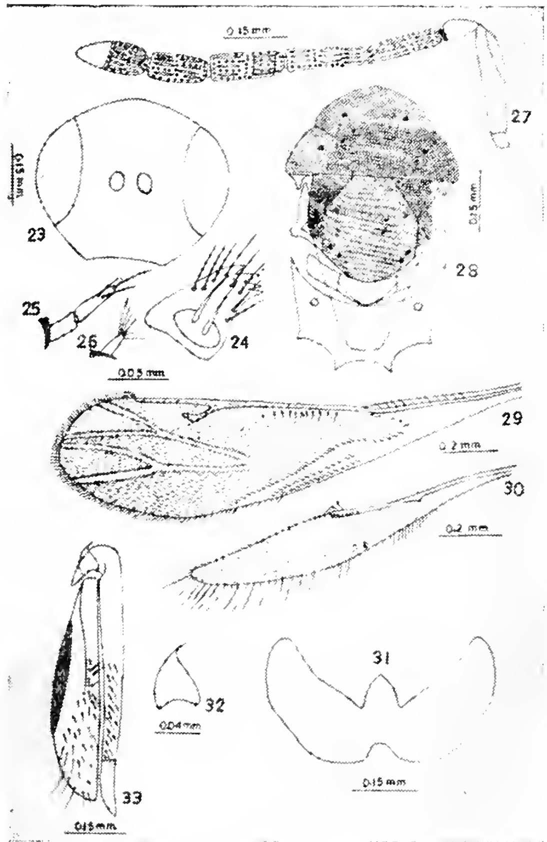
Gokulpure (1972) recorded the genus (*Hemiptarsenus* sp.) for the first time from India parasitic on the *Phytomyza atricornis* (Meigen). In the present work a new species *Hemiptarsenus indicus* is described.

Hemiptarsenus indicus sp. nov.
(Figs. 23-33)

FEMALE. (Fig. 23). Dark brown with golden reflections, wider than long in facial view (0.44 : 0.4), width of frons between eyes slightly more than half of head width, frontovertex wide, ocelli arranged in obtuse angle triangle; malar space as long as transverse diameter of eye (0.11: 0.11), distance between two antennal sockets almost twice the distance from eye rim (0.04: 0.075); antennae inserted in the middle of face; mandibles quadridentate with sharp apices (Fig. 24), maxillary (Fig. 25) and labial palp (Fig. 26) two and one segmented respectively.

Antennae (Fig. 27). Dark brown except scape yellowish with a dark band on dorsal surface of the apical half, apical one third of the club yellowish; antennae eight segmented consisting of scape, pedicel, an anellus, three segmented funicle and an unsegmented club. Scape slightly dilated, less than five times longer than wide, pedicel twice longer than wide (0.08 : 0.04), less than half of first funicle segment, an anellus intervening between the pedicel and first funicle segment, funicle segments longer than wide, first and second segment subequal in size (0.19 : 0.04), third segment (0.17: 0.06) shorter than second, fourth funicle segment very short (0.13: 0.06); club unsegmented, less than three times longer than wide (0.17: 0.06), longer than preceding segment.

Thorax (Fig. 28). Dark brown, uniformly reticulate sculpture; scutum less than twice wider than long (0.45 : 0.24), with incomplete parapsidal furrows, with four long, strong bristles, axillae triangular, widely separated from each other; scutellum wider than long, shorter than scutum, without any bristle,



Figs. 23-33. *Hemiptarsenus indicus* sp. nov., ♀ 23. Head, frontal aspect; 24. Mandible; 25. Maxillary palp; 26. Labial palp; 27. Antenna; 28. Thorax, dorsal aspect; 29. Fore wing; 30. Hind wing; 31. Subgenital plate; 32. First valvifer; 33. Ovipositor.

scutum with its axillae resembles with that of an encyrtid; surface of the propodaeum smooth, propodael spiracle separated from anterior margin by a space equal to twice the diameter of a spiracle, mesopostphragma short.

Forewings (Fig. 29). Hyaline, slightly less than four times longer than wide (1.4 : 0.38), densely setose with two longitudinal Y shaped light brownish bands, bands are rather densely setose, basal area of parastigma sparsely setose; costal cell narrow with 11 setae, submarginal vein with 10 dorsal bristles, marginal vein (0.46) almost twice the length of postmarginal vein (0.25), stigmal vein (0.09) short; 10 admarginal hairs present, marginal fringe long, spaced by a distance equal to more than $\frac{1}{4}$ length of a fringe.

Hindwings (Fig. 30). Hyaline, narrow, less than seven times longer than wide, densely setose, 3 curved hooklets at apex of marginal vein, marginal fringe long.

Forelegs. Uniformly yellowish except apical half of coxa and tarsal segment 2-4 brownish.

Middle legs. Uniformly yellowish except coxa and tarsal segments 2-4 brownish, femora with a single, strong setae at basal end.

Hind legs. Uniformly yellowish except coxa on major portion, basal half of femora and tarsal segments 2-4 dark brownish.

Abdomen. Brownish with yellowish reflections, slightly longer than thorax; petiole yellow, short, subgenital plate (Fig. 31) with anterior margin cone like in the middle, posterior margin with a deep notch in the centre, first valvifers (Fig. 32) triangular with articular knobs prominent, third valvulae (Fig. 33) movably articulated with second valvifers; outer plates of ovipositor (Fig. 33) narrow at base, rounded at apex, dorsal margin thickened, with a ridge in the middle, ovipositor slightly exserted.

Female length. 1.61 mm.

MALE. Not known.

Holotype. ♀, INDIA, U.P., Pantnagar, ex *Chromatomyia horticola* (Diptera: Agromyzidae) on field peas *Pisum sativum* 3-1-1979 Hym. Eulo. Nr. 1011 (M. A. Khan).

Paratype. 1 ♀ (Same data as Holotype) Hym. Eulo. Nr. 1012 (M. A. Khan).

Hemiptarsenus indicus sp. nov. resembles *Hemiptarsenus unguicellus* (Zetterstedt) from which it can be distinguished in Table 1.

TABLE 1

Hemiptarsenus unguicellus (Zetterstedt)	*Hemiptarsenus indicus* sp. nov.
Antennal scape blackish	Antennal scape yellowish with a dark band on apical half
Thorax wholly metallic	Thorax dark brown
Forewings usually immaculate	Forewings with two longitudinal Y shaped light brownish bands which are rather densely setose
Legs uniformly yellowish except coxae wholly or partly brown, tarsal segment 2-4 brown	Legs with hind and mid coxae concolorous with thorax and occassionally femora infuscate medially
Petiole strongly transverse	Petiole yellow, short but not transverse
Mandible not likewise	Mandible quadridentate with sharp apices.

Pediobius Walker 1846 (= **Pleurotropis** Forester 1856)

Pediobius Walker, 1846, Ann. Mag. Nat. Hist. 17-184.

Type species—*Entedon (Pediobius) imbreus* Walker Desig. by Ashmead 1904, P. 384.

Ferriere (1953) considered the genus *Pleurotropis* Forester to be a synonym of *Pediobi-*

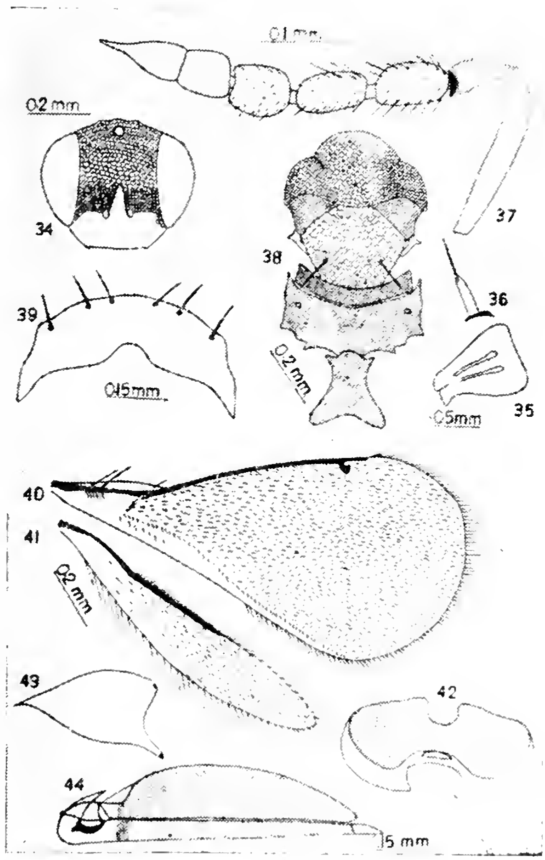
us Walker. Crawford (1912) recorded the genus for the first time from India while describing *Pleurotropis foveolatus* parasitic on the larvae of Epilachna beetle. Rohwer (1921) reported another new species *P. epilachnae* parasitic on the same host. There are only ten species reported from India so far. Here in the present work *P. indicus* is described as a new species.

The genus *Pediobius* Walker can easily be separated from other genera in having body strongly sclerotized, head (Fig. 34) and thorax (Fig. 38) with fine sculpture, parapsidal furrows usually partly indicated, scutellum without distinct median groove, abdomen convex with distinct petiole, propodaeum with complete plicae and two submedian longitudinal carinae diverging posteriorly, latter rarely vague and replaced by narrow basal elevation moderately sloping backward, pronotal collar carinate.

Some new generic characters are suggested namely mandible bidentate (Fig. 35,) maxillary (Fig. 36) and labial palp each one segmented, subgenital plate (Fig. 42) of uniform width, anterior margin almost straight, posterior margin with a deep notch in the middle, first valvifer (Fig. 43) triangular with basal margin concave, third valvulae very short (Fig. 44), outer plate of ovipositor (Fig. 44), narrow at base, gradually widen in the middle and finally turns narrow at apex.

Pediobius indicus sp. nov.
(Figs. 34-44)

FEMALE. *Head* (Fig. 34). Dark metallic with predominantly bright bluish green reflections on the face, with fine reticulate sculpture, wider than long in facial view (0.5 : 0.42); frontovertex wide, one half of head width (0.25 : 0.5); ocelli arranged in obtuse angle triangle, basal ocelli almost twice its diameter from eye rim and removed from occipital margin by its own diameter, eyes large, reaching near to the facial margin; malar space very short (0.1); distance between two antennal sockets less than half the distance from eye rim (0.04 : 0.09), their lower margin well above the line drawn across lower eye margins; mandibles bidentate with blunt tooth



Figs. 34-44. *Pediobius indicus* sp. nov., ♀. 34. Head, frontal aspect; 35. Mandible; 36. Maxillary palp; 37. Antenna; 38. Thorax; dorsal aspect with Petiole attached; 39. Pronotum; 40. Fore wing; 41. Hind wing; 42. Subgenital plate; 43. First valvifer; 44. Ovipositor.

(Fig. 35), maxillary (Fig. 36) and labial palp one segmented each.

Antennae (Fig. 37). Dark brown, scape cylindrical, less than seven times longer than wide (0.19 : 0.03); pedicel long, more than twice longer than wide (0.065 : 0.03), shortter than first funicle segment (0.08: 0.05); an anellus present between pedicel and first funicle segment; funicle three segmented, first funicle segment (0.8 : 0.05) a trifle longer than second (0.75 : 0.05), third segment quadrate (0.06 : 0.06), club two segmented, three times as long as wide (0.15 : 0.05), almost as long as preceding two funicle segments combined.

Thorax (Fig. 38). Dark metallic with shining green reflections on the dorsum, with fine reticulate sculpture, pronotum as shown in Fig. 39, its posterior margin with six strong setae; scutum less than twice wider than long (0.45: 0.25) with incomplete parapsidal furrows, with four bristles, axilla widely separated from each other; scutellum wider than long (0.35 : 0.25), shorter than scutum, with two long bristle; propodaeum highly carinated.

Forewings (Fig. 40). Hyaline, less than twice longer than wide, densely setose, costal cell narrow; submarginal vein with two stout, strong setae, six small setae arranged downwards, basal vein with three setae; subcubital line of hairs with only seven small setae; marginal vein very long (0.56); postmarginal vein (0.07) almost twice the length of stigmal vein (0.04), 13 admarginal hairs present; marginal fringe short, spaced by a distance equal to one third their length.

Hindwings (Fig. 41). Hyaline, almost six times longer than wide, marginal fringe short, spaced by a distance equal to one half their length.

Forelegs. Uniformly brown with tarsal segment except first light brownish.

Middle legs. Dark brown except apex of coxa, apex of trochanter, apical end of tibiae and tarsal segments 1-3 whitish; apical rim of tibiae with 3 small pegs.

Hindlegs. Coloration same as that of forelegs except tarsal segments 1-3 white, last segment dark brown.

Abdomen. Dark brown with bluish green reflections on the dorsum, longer than thorax (0.75 : 0.6), petiole almost one and a half times longer than wide; ovipositor slightly exserted; subgenital plate (Fig. 42) of uniform width, anterior margin almost straight, posterior margin with a deep notch in the middle; first valvifer (Fig. 43) triangular with basal margin concave, articular knobs prominent; second valvifer of uniform width; third valvulae very short (Fig. 44), movably articulated with second valvifer; outer plate of ovipositor (Fig. 44) narrow at base, gradually widen in the middle and finally turns narrow at apex.

Length of female. 1.7 mm.

MALE. Not known.

Holotype. ♀, INDIA, U. P. Pantnagar, ex. *Chromatomyia horticola* (Diptera : Agromyzidae) on field peas —*Pisum sativum.* 3-1-1979. Hym. Eulo. Nr. 1013 (M. A. Khan).

Paratype. Same data as holotype Hym. Eulo. Nr. 1014 (M. A. Khan).

P. indicus sp. nov. is easily distinguished from the related *P. mitsukurii* (Ashmead) as in Table 2.

Genus **Euderus** Haliday

Euderus Haliday, 1843. Trans. Ent. Soc. Lond. 3 : 298.

Type species : *Entedon amphis* Walker.

The genus *Euderus* Haliday can be easily recognized from other eulophid genera by the presence of 3 hair lines radiating from the base of stigmal vein, by the postmarginal vein in the forewing and by complete notaulices.

TABLE 2

P. mitsukurii (Ashmead)	*P. indicus* sp. nov.
Frontovertex about 1.5 times breadth at its median length.	Frontovertex about 0.5 times breadth at its median length.
Eyes moderately hairy.	Eye bare.
Scape slightly swollen at its apical one third, five times as long as broad.	Scape uniformly cylindrical seven times as long as broad.
Pedicel as long as first funicle segment, slightly less than twice as long as wide, flagellum rather slender, hardly stouter than pedicel.	Pedicel shorter than first funicle segment, more than twice longer than wide, flagellum stouter than pedicel.
Funicle segment subequal in length, about 1.5 as long as broad, club as long as pedicel and first funicle segment.	Funicle segment not subequal in length, first funicle segment a trifle longer than second, third segment quadrate, club two segmented, shorter than pedicel and first funicle segment.
Costal cell bare.	Costal cell not bare.
Post marginal vein more than twice as long as stigmal vein.	Post marginal vein twice the length of stigmal vein.
Coxae concolorous with thorax, rest of the leg pale brownish yellow.	Legs not likewise uniformly dark brown coloration with some parts white.

Recently the genus has been well revised by Yoshimoto (1971) and distinguishing characters given by him apply well to the species under study. In addition some new generic characters are suggested which may further help in distinguishing *Euderus* from allied genera, *viz.* (i) first valvifer semicircular with base little concave; (ii) second valvifer with dorsal margin thickened; (iii) outer plates of ovipositor narrow at base, gradually widening posteriorly with a submarginal ridge running three fourth length of dorsal margin.

Euderus agromyzae Gangrade
(Figs. 45-56)

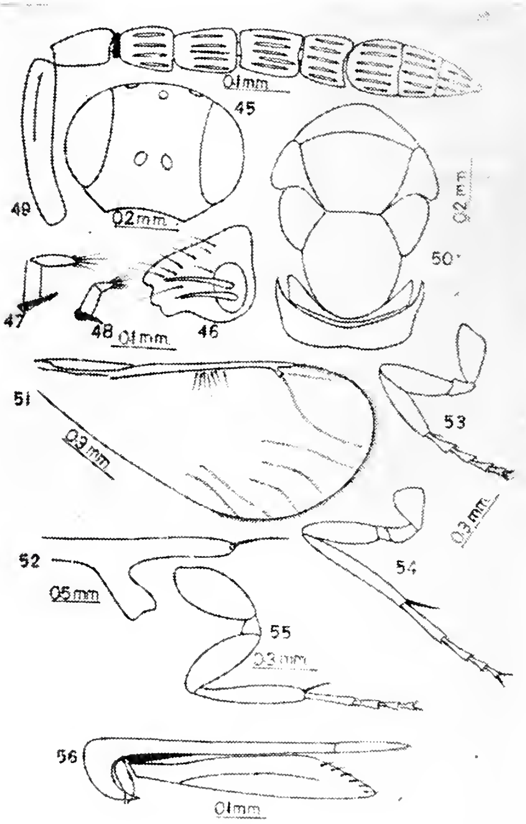
Euderus agromyzae Gangrade 1960, Indian J. Ent. 22 : 80-82.

FEMALE. (redescribed in detail). *Head.* (Fig. 45) : Dark brown with metallic reflections, surface reticulate, wider than long in facial view (0.63 : 0.45), fronto-vertex wide (0. 32), wider than long, one half of head width; eyes large; bare, more than twice longer than wide; Ocelli arranged in obtuse angle triangle; antennal sockets placed in the middle, well above the imaginary line joining the orbital border, distance between the two antennal sockets less than twice their distance from eye; mandibles tridentate with acute teeth (Fig. 46); maxillary (Fig. 47) and labial palp (Fig. 48) two segmented.

Antenna (Fig. 49). Dark brown except the scape with ventral side yellowish; scape less than six times longer than wide (0.23 : 0.04); pedicel distinctly less than twice longer than wide (0.09: 0.05) longer than first funicle segment (0.08), anellus very small; funicle segments cylindrical except fourth segment quadrate, second and third funicle segment subequal in size (0.09 : 0.07); club three segmented, less than three times longer than wide (0.21 : 0.08), longer than preceding two funicle segments combined; first funicle to last club segments with 7, 9, 12, 14, 16, 10, 8 and 5 sensoria respectively.

Thorax (Fig. 50). Dark brown with reticulate sculpture, pronotum short, narrow; scutum wider than long (0.58 : 0.4); scutel-

lum slightly longer than wide (0.38 : 0.35), shorter than scutum, rounded at apex; propo-



Figs. 45-56. *Euderus agromyzae* Gangrade. 45. Head, frontal aspect; 46. Mandible; 47. Maxillary palp; 48. Labial palp; 49. Antenna; 50. Thorax, dorsal aspect; 51. Fore wing; 52. Fore wing venation; 53. Fore leg; 54. Middle leg; 55. Hind leg; 56. Ovipositor.

daeum reticulate with median carina very short.

Forewings (Fig. 51). Hyaline, sparsely setose, almost twice longer than wide; posterior and apical margin with five hair lines, seven admarginal hairs present; submarginal vein subequal to marginal vein, with seven long dorsal setae; post marginal vein twice the length of stigmal vein (Fig. 52), marginal fringe short.

Hindwings. Almost three times as long as wide, sparsely setose, apex of marginal vein with three curved hooklets; marginal fringe short.

Forelegs (Fig. 53). Uniformly brownish except the first tarsal segment almost white; coaxe with eight long setae on outer face of distal half; femora thickened; tibiae with a small spur.

Middle legs (Fig. 54). Coloration same as of fore legs except the last tarsal segment dark brown; tibial spur long.

Hind legs (Fig. 55). Coloration same as of middle legs.

Abdomen. Dark brown, longer than thorax; petiolate, tapering at apex; ovipositor concealed; first valvifer semicircular (Fig. 56) with base little concave, articular knobs prominent, second valvifer long with dorsal margin slightly thickened, third valvulae (Fig. 56) narrow, movably articulated with second valvifers, outer plates of ovipositor (Fig. 56) narrow at base, gradually widening posteriorly with a submarginal ridge running three fourth length of dorsal margin.

Length of female. 2.25 mm.

MALE. Resembles female except head and thorax non-metallic, abdomen shorter than head and thorax combined, pale brown to dark.

Length of Male. 1.9 mm.

Holotype, ♀, ♂ INDIA, U.P., Pantnagar ex *Melangromyza obtusa* (Diptera: Agromyzidae) in the pods of *Cajanus cajan* 10-11-1979. Hym. Eulo. Nr. 1015 (M. A. Khan).

Paratype. Same data as holotype Hym. Eulo. Nr. 1016 (M. A. Khan).

ACKNOWLEDGEMENTS

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A NEW SPECIES OF THE GENUS *SIMOCEPHALUS* SCHOEDLER, 1858 (CLADOCERA, DAPHNIIDAE) FROM MADHYA PRADESH, INDIA[1]

PRAMOD RANE[2]

INTRODUCTION

Cladocera of the genus *Simocephalus* Schoedler, 1858 are not so well known from India. Biswas (1965, 1980) reported six species from Rajasthan and North East India, and I (1983) have described *S. vidyae* sp. nov. from Tewar, Jabalpur district, Madhya Pradesh, India. Recently again I came across several specimens of *Simocephalus* sp. from Deotal, Madhya Pradesh. A female specimen of the

[1] Accepted March 1984.

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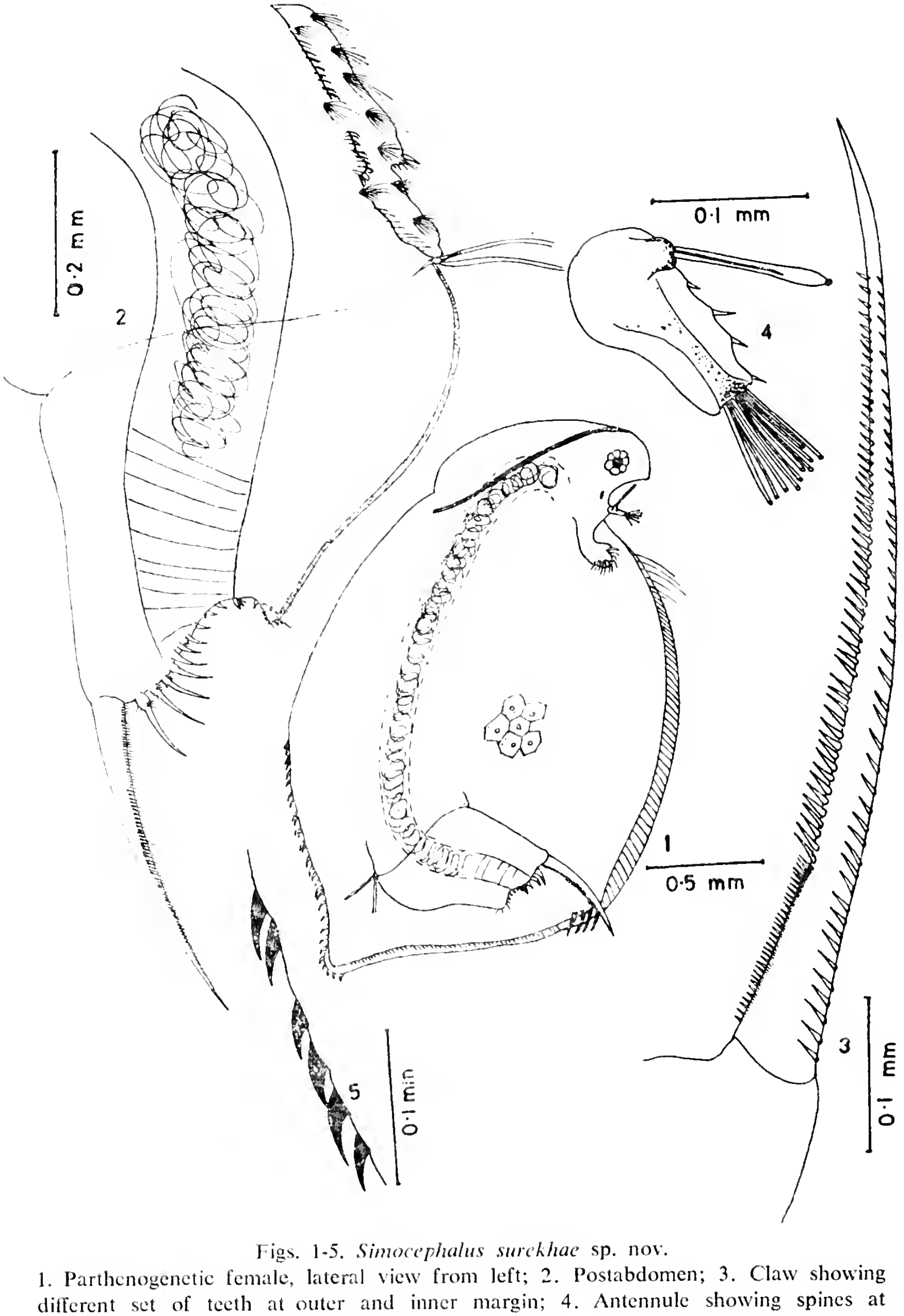

Figs. 1-5. *Simocephalus surekhae* sp. nov.
1. Parthenogenetic female, lateral view from left; 2. Postabdomen; 3. Claw showing different set of teeth at outer and inner margin; 4. Antennule showing spines at anterior margin; 5. Hook-like denticles of posterior dorsal half margin of valve.

above lot is described here as a new species, it differs both from *S. vidyae* Rane described from Tewar, M. P. and *S. exspinosus* (Koch) reported from North West India. The other specimens of the same lot are paratypes.

Simocephalus surekhae sp. nov. (Figs. 1-5)

DESCRIPTION. FEMALE. Carapace seen laterally is broad, oval or somewhat rhomboidal in outline, with a well marked protuberance posteriorly; dorsal margin evenly curved; posterior edge of the valve nearly straight and rather oblique, joining the ventral edge at a well-marked angle. Posterior half of the dorsal margin strongly denticulate; paired, hook-like, continued to the terminal protuberance. Ventral posterior half of valve almost straight, with several small, equal denticles attached submarginally. Head small, angulate, with dorsal margin evenly curved. Rostrum absent. Antennules with ten terminal aesthetascs and lateral sensory seta originate from knob-like expansion. 3-4 spines present along the anterior edge of the antennules. Eye comparatively large, with refractive bodies conspicuous. Ocellus small, rhomboidal. Very large tongue-like expansion present at the ventral margin of head, clothed with several large hairs. Valves with distinct pattern of polygon cells at various places. Postabdomen broad posteriorly, with acute supra-anal angle, anal denticles 11-12 on each side. Proximal four large, decreasing in length posteriorly with groups of hairs on both upper and lower side. Postabdominal claw nearly straight, spinulated both on the outer and inner margins. Outer margin with two sets of teeth. Proximal set with 30 small equal teeth about two-thirds as long as longest and half as broad as broadest teeth of the distal set. Distal set with about 50 teeth, decreasing gradually toward the tip of claw. Inner margin of claw also with 44-45 teeth about three-fourths as long as longest of distal set at outer margin. Length of female, 1.8 to 2.4 mm and height 1.32 to 1.84 mm.

MALE unknown.

Material examined. INDIA. Madhya Pradesh, Jabalpur district, Kola tank near Deotal on Nagpur Road, Holotype ♀ and 10 ♀♀ paratypes, 5 October, 1981, Coll. P. D. Rane; deposited in the National Collection of Zoological Survey of India, Calcutta, West Bengal.

Remarks. Literature reveals that only two spinulated species of *Simocephalus* are known so far from India, namely *S. vidyae* Rane and *S. exspinosus* (Koch) which have 13 to 15 and 9 to 12 teeth respectively in the proximal pecten. *S. surekhae* sp. nov. can be differentiated from the above species in having 28-30 and 47-50 teeth, respectively in the proximal and distal part of claw, at outer margin. The teeth in proximal part of *S. surekhae* appear similar to those of *S. exspinosus*, having the same size throughout but differing in their numbers. *S. vidyae* Rane comes close to the new species in having angulate vertex and spinulate claws but differs by its very large rostrum and larger teeth in the proximal pecten. In addition to above differences, the large 3-4 spines at the anterior edge of antennules, absence of rostrum and different spination on both outer and inner margin of claw are unique characters only for the new species.

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THREE NEW SPECIES OF *PEDIOBIUS* WALKER (HYMENOPTERA: EULOPHIDAE) FROM SOUTH INDIA[1]

S. ADAM SHAFEE AND SEEMA RIZVI[2]

(*With nine text-figures*)

Three new species of *Pediobius* Walker (*P. gunturensis* sp. nov., *P. pondicherryensis* sp. nov. and *P. maduraiensis* sp. nov.) are described and illustrated. The new species are differentiated from their closely allied species. Types are deposited in Zoological Museum, Aligarh Muslim University, Aligarh, India.

Pediobius gunturensis sp. nov.
(Figs. A-C)

FEMALE. Head dark, strongly sclerotized and distinctly sculptured; distinctly wider than long in facial view; frontovertex slightly less than one-half the total head width; ocelli white, arranged in obtuse triangle, lateral ocellus separated by its diameter from inner orbital margin and close to occipital margin; malar space slightly shorter than eye width; malar sutures indistinct; antennae inserted just above lower level of eyes, inter-antennal space about one-fourth the width of frons between eyes at median ocellus. Antennae dark except scape yellowish brown (fig. A); scape cylindrical, slightly less than five times as long as wide; pedicel one and a half times as long as wide, slightly shorter than first funicle segment; one ring segment present; funicle segments I-3 gradually decreasing in length and increasing in width distad, first twice as long as wide, third slightly longer than wide; club 2-segmented, slightly more than twice as long as wide, shorter than preceding two funicle segments together.

Thorax dark, strongly sclerotized and distinctly sculptured; posterior margin of pronotum with six thick setae; mesoscutum with two pairs of long setae, parapsidal furrows indistinct; scutellum with a pair of long setae; propodeum dark, strongly sclerotized with metallic bluish reflections. Fore wings (fig. B) hyaline, slightly more than twice as long as wide; disc with basal one-third naked except a row of six setae; costal cell broad, bare, shorter than marginal vein; submarginal, premarginal, marginal and post-marginal veins with 2, 5, 14 and 3 setae respectively; postmarginal vein slightly longer than stigmal vein (fig. C); a row of 12 long setae beneath marginal vein; marginal fringe short, spaced by a distance equal to one-third their length. Legs dark except apical three-fourth of mid and hind tibiae, apical one-third of fore tibiae and tarsi of all legs white.

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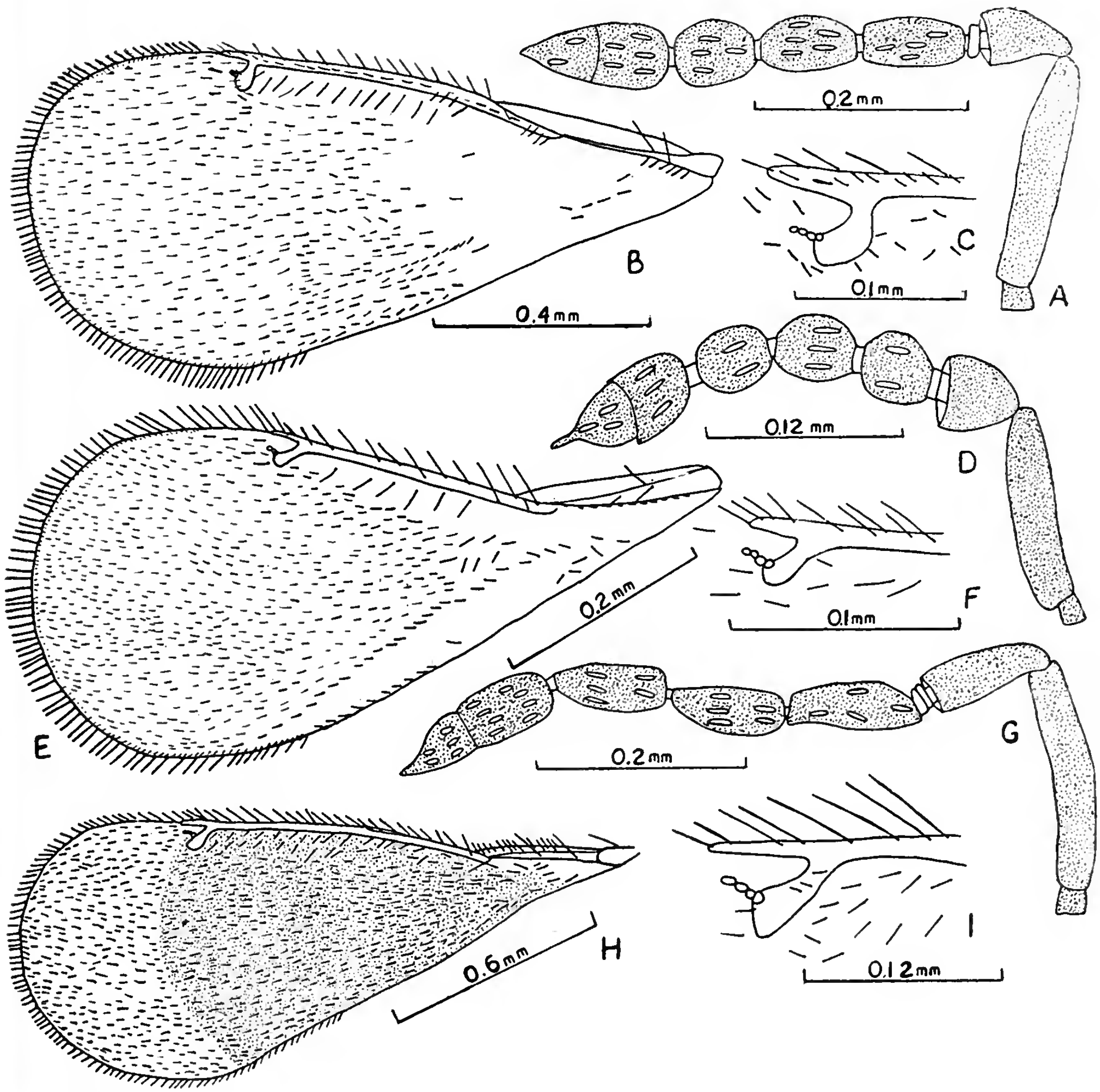

Figs. A-C. *Pediobius gunturensis* sp. nov.. ♀ : (A) Antenna, (B) Fore wing, (C) Part of fore wing venation.
Figs. D-F. *Pediobius maduraiensis* sp. nov., ♀ : (D) Antenna, (E) Fore wing, (F) Part of fore wing venation.
Figs. G-I. *Pediobius pondicherryensis* sp. nov., ♀ : (G) Antenna, (H) Fore wing, (I) Part of fore wing venation.

Abdomen dark with metallic reflections, distinctly longer than thorax; ovipositor slightly exserted, arising from base of abdominal venter; first abdominal tergite short, about one-fourth the length of abdomen.

Body length. 1.84 mm.

Holotype ♀. INDIA: Andhra Pradesh, Guntur, 4. iii. 1982 (*S. Adam Shafee*).

Comments: The new species is closely related to *Pediobius longicorpus* Khan and Shafee (1982) from which it can be separated in having antennae with one ring segment, funicle segment third slightly longer than wide; marginal vein of fore wing with I4 long setae and row of I2 long setae beneath marginal vein.

Pediobius maduraiensis sp. nov.
(Figs. D-F)

FEMALE. Head dark, reticulately sculptured; frontovertex slightly wider than long; ocelli white, arranged slightly in obtuse triangle, lateral ocellus separated by twice its diameter from inner orbital and occipital margins separately; antennae inserted on lower level of eyes; malar space slightly shorter than eye width. Antennae (fig. D) dark with metallic reflections; scape cylindrical, four times as long as wide; pedicel as long as wide, as long as first funicle segment; one ring segment present; funicle segments I-3 rounded, first and third subequal, second slightly longer than first; club 2-segmented.

Thorax dark, strongly sclerotized and distinctly sculptured; posterior margin of pronotum with thick setae. Fore wings (fig. E) hyaline, slightly more than twice as long as wide; disc sparsely setose; costal cell narrow, bare, slightly more than one-half the length of marginal vein; submarginal, premarginal, marginal and postmarginal veins with 3, 2, II and 4 setae respectively; postmarginal as long as stigmal vein (fig. F); marginal fringe short, spaced by a distance equal to one-fourth their length. Legs dark, except tarsal segments I-3 white.

Abdomen dark, about as long as thorax; ovipositor hidden.

Body length: 0.8 mm.

Holotype ♀. INDIA: Tamil Nadu, Madurai, 10.iii.1982 (*S. Adam Shafee*).

Comments : The new species is closely related to *Pediobius inexpectatus* Kerrich (1973), from which it can be separated by its having tarsal segments I-3 of all legs white, obtuse triangular arangement of ocelli, absence of carinae from lateral ocelli to orbital margins.

Pediobius pondicherryensis sp. nov.
(Figs. G-I)

FEMALE. Head dark with metallic bluish reflections, finely setose; strongly sclerotized and distinctly sculptured; distinctly wider than long in facial view; ocelli brownish, arranged in obtuse triangle, lateral ocellus separated by about its diameter from inner orbital margin and less than its diameter from occipital margin; antennae inserted just above lower level of eyes; inter-antennal space about one-third the width of frons between eyes at median ocellus; malar space shorter than eye width. Antennae (fig. G) dark with metallic reflections; scape cylindrical, five times as long as wide; pedicel two and a half times as long as wide, as long as first funicle segment; two ring segments present; funicle 3-segmented, segment first longest, two and a half times as long as wide, second and third subequal, each slightly more than twice as long as wide; club 2-segmented, shorter than preceding two funicle segments together.

Thorax dark with metallic bluish reflections, strongly sclerotized; posterior margin of pronotum with six long setae; mesoscutum reti-

culate, sparsely setose, parapsidal furrows present anteriorly; scutellum distinctly sculptured, densely setose. Fore wings (fig. H) infuscated except a transverse broad band beyond venation hyaline, infuscated area with coarse setae; slightly more than twice as long as wide; costal cell narrow with row of fine setae, less than half the length of marginal vein; submarginal, premarginal, marginal and postmarginal veins with 2, 2, 22 and 3 long setae respectively; postmarginal vein slightly longer than stigmal vein (fig. I). Legs dark except tarsal segments of fore legs brownish, tarsal segments I-3 of mid and hind legs white; hind femora thickened with lower margin dentate.

Abdomen dark with metallic reflections, slightly longer than thorax; ovipositor hidden, arising from basal one-third of abdominal venter; first abdominal tergite short, one-sixth length of abdomen.

Body length: 1.7 mm.

Holotype ♀. INDIA: Pondicherry, 15.iii.1982 (*S. Adam Shafee*).

Comments: The new species differs from all the known species of *Pediobius* in having fore wings with infuscation beneath venation, costal cell with a row of fine setae, thickened hind femora with dentate lower margin.

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We are deeply indebted to Prof. Nawab H. Khan, Chairman, Department of Zoology, for providing research facilities.

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A NEW SPECIES OF AMPHIPOD, *HYALE GOPALASWAMYI* SP. NOV. — A COMMENSAL OF SPONGES[1]

M. R. KANAKADURGA, K. HANUMANTHA RAO AND K. SHYAMASUNDARI[2]

(*With twenty two text-figures*)

Hyale gopalaswamyi sp. nov. an amphipod (Crustacea) was collected from the sponge, *Callyspongia fibrosa,* washings from Visakhapatnam coast. *H. gopalaswamyi* sp. nov. differs from its allied species in the presence of a groove for the dactylus fitting into the palm of gnathopod 2, striated spines on the propodus of pereopods 1-5 and the telson lobes being set apart from each other.

Family. HYALIDAE

Genus. **Hyale** Rathke, 1837

Hyale gopalaswamyi sp. nov.

DIAGNOSIS. Maxilla 1 with 1 articulate palp; article 4 of maxillipedal palp unguiform; gnathopods subchelate in both sexes, male gnathopod 2 longer than 1; article 5 not projecting between articles 4 and 6, female gnat-

[1] Accepted October 1984.

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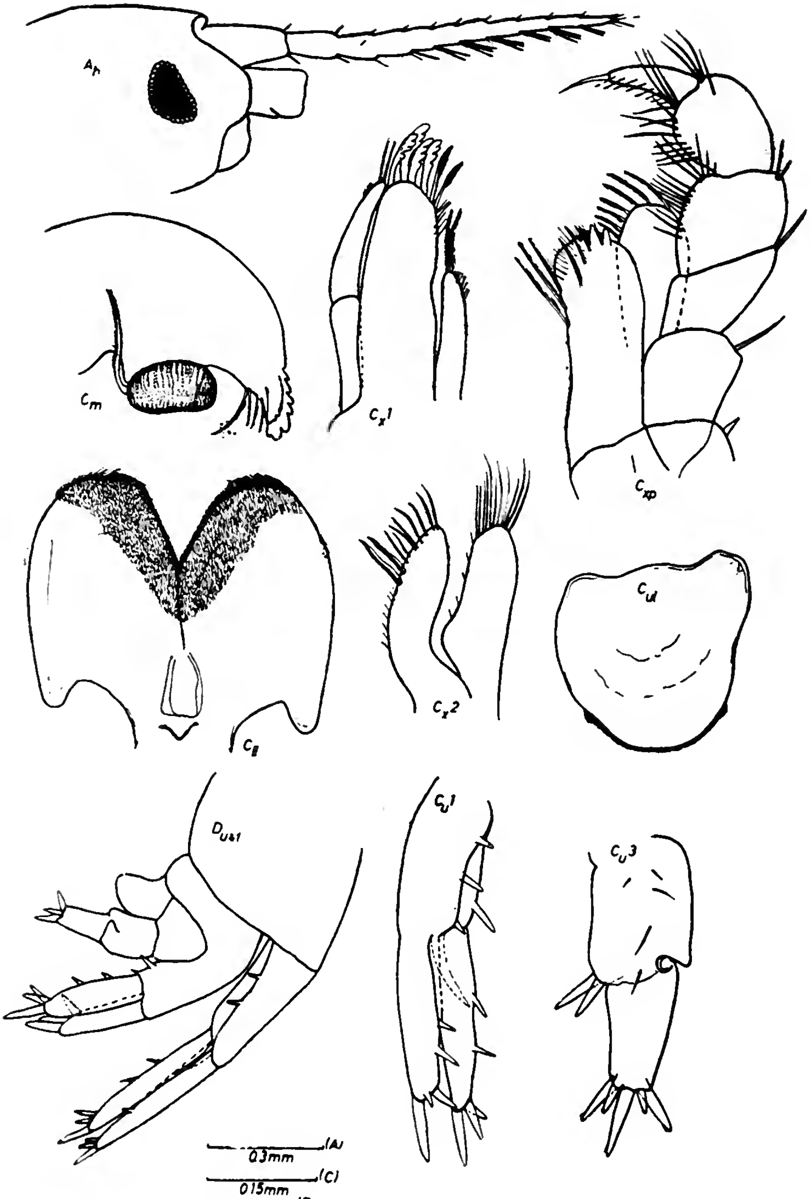


Fig. 1-10. *Hyale gopalaswamyi* sp. nov.
h — Head with antenna 1; ll — Lower lip; m — Mandible; ul — Upper lip; u&t — Uropods and telson; u^1 — Uropod 1; u^3 — Uropod 3; x^1 — Maxilla 1; x^2 — Maxilla 2; xp — Maxilliped. A, C and D are the scale measurements.

hopod 2 like gnathopod 1; uropod 3 lacking inner ramus, telson cleft.

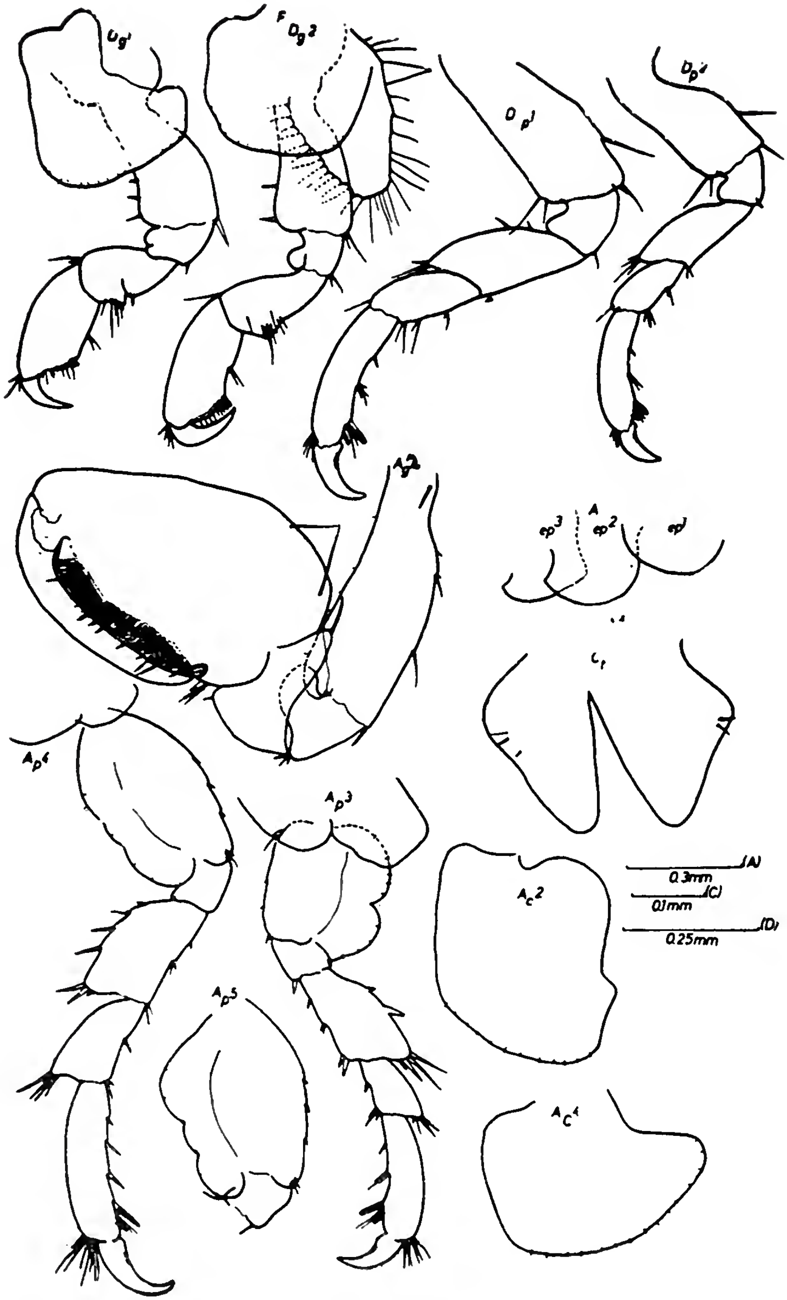
MALE. (Length 5 mm).

Body robust, dull white in colour, eephalon smaller than the first two pereon segments: ocular lobes produced; eyes large, oval in shape with eentral black uneven core and peripheral oeelli. Antennae unequal: Antenna 1; three fourths length of 2nd; pedunele shorter than that of antenna 2 and peduncular articles subequal, primary flagellum with 8-10 subsimilar articles, asthetascs present along with setae at the base of each article. Antenna 2; Slightly smaller than body length, basal peduncular article broader 2nd article longer and 3rd article half the length of 3rd, flagellum with 14 subsimilar articles bearing small spines at their apices.

Upper lip. Longer than broad, evenly rounded at ventral margin, bearing long setules. Mandible: Palp absent, ineisor toothed, laeinia mobilis with 5 projections spine row with 4 large pinnate spines; molar large with transverse ridges and a long plumose seta; Maxilla 1 : inner plate distally narrow, bearing two long plumose setae and inner marginal setae: outer plate with inner apieal setac and 6 barbed spines; palp slender, slightly longer than outer palp with spines and a few sub-apical setae: Maxilla 2 : Plates slender, inner plate earrying 1 long plumose seta, subapically 7-8 pinnate spines and a few fine setae apically, outer plate with setules on inner margin and long setules at the apex; Lower lip : Inner lobes absent, lobes setose at the apical region. mandibular process short and decurrent: Maxilliped : Inner plates reetangular with 3 ehisel teeth and a median apieal row plumose setae present; outer lobe reaching half of 2nd palp artiele, earrying plumose setae at the inner margin. 2nd and 3rd palpar artieles setose. 3rd horse-shoe shaped. 4th artiele slightly smaller than 3rd, with a pointed spine.

Gnathopods 1 and 2 subchelate. Gnathopod 1: Coxal plate angular in shape, anterior border straight. Basal article broadens distally with 3 submarginal spine setae and one spine present distally; isehium small and broader. merus also widens distally, carpus smaller than merus and triangular with 6 spinules; propodus reetangular in shape, palm oblique with setose margin; 2 spines present, at the palmar edge, daetylus scarcely reaching the defining spines and distally narrow. Gnathopod 2: Coxa 2 rounded ventrally; basal article widens distally, merus small and widens to form a protrusion, with a few spine setae at the distal margin; carpus triangular in shape, with single seta on either side of the distal margin; propodus very long and broad; nearly rectangular in shape; the basal palmar margin ends in a cavity into whieh the dactylus fits. followed by two blunt spines and setae; the dactylus long and narrows distally.

Pereopod 1 and 2 subsimilar; pereopod 1 longer than perepod 2. coxal plate almost rectangular in shape; ventral margin with minute spinules. Basal article longer than that of gnathopod 2, widens towards distal margin: merus very small, rectangular in shape, widens distally and possesses a protuberanee along the ventral margin. Carpus smaller and three fourths length of propodus, spine setae arise as fascicles along inner margin; propodus thrice the length of carpus bearing 3 large striated spines on inner margin; last spine the largest; daetylus eurved with 4-5 setae at its base anteriorly. Pereopod 3: Coxal plate with two lobes: basis broad with lobate and spinulate ventral margin; isehium small; merus as long as propodus and produeed antero-distally with spine setae at its apex and prominent spines along the margins; carpus half the length of propodus, it also widens antero-



Figs. 11-22. *Hyale gopalaswamyi* sp. nov.
G^1 — Gnathopod 1; g^2 — Gnathopod 2; fg^2 — Female gnathopod 2; p^1, p^2, p^3, p^4 & p^5 — Pereopods 1, 2, 3, 4 & 5; ep^1, ep^2 & ep^3 — Epimeron 1, 2 and 3; c^2 — Coxa 2; c^4 — Coxa 4; t — Telson.

distally, distal apical and marginal spines present; propodus elongate, spines subsimilar to those of pereopod 2. Pereopod 4 and 5 subsimilar except for the longer and broader basis in 5th, propodus with 5 striated spines on inner margin; dactylus curved.

Pleon. Smooth dorsally, 1st epimeron subrounded, ventral margins of pleon 2 and 3 subrounded and produced to small tooth postero-ventrally without any spines.

Uropod 1. Peduncle subequal to rami in length, with 1 large apical spine and 3 outer and 1 inner marginal spines; rami subequal in length, outer ramus with one marginal spine and 3 distal apical spines; inner ramus with 2 inner marginal spines, apex subsimilar to that of outer ramus.

Uropod 2. Subequal and subsimilar to uropod 1 except in which peduncle lacks distal marginal elongated spine.

Uropod 3. Uniramus, peduncle as long as the ramus and broad, with 5 median spines and 2 stout inner apical spines, ramus with unarmed margin, with 5 apical stout spines.

Telson: Cleft to base, lobes conical, each with 2 outer median submarginal setae, left lobe with a small median submarginal seta.

FEMALE. (Length 6 mm).

Coxa 2. Quadrangular in shape with spinules along the ventral margin. Basis broad and short, ischium small with roundly produced outer margin; merus as long as carpus; carpus triangular in shape with inner apico-marginal setae; propodus double the length of carpus and rectangular in shape; palm oblique with few spines alternating with setae. Palmar margin ends in 2 spines. Anterior basal region of the dactylus possesses elongated setae.

The holotype specimen was deposited in the museum of the Zoology Department of Andhra University. Waltair and the paratype specimens will be deposited in the museum of Zoological Survey of India, Calcutta.

Discussion

This specimen closely resembles *Hyale rubra* (Thomson 1879) from Australia and it forms an intergrade between *Hyale honoluluensis* Shellenberg 1938 and *Hyale ayeli* (Barnard 1970).

The present specimen resembles *Hyale rubra* in the structure of the head, mandible, maxilliped, shape of gnathopod 1, striated spines on the propodus of pereopods 2 to 5, and it differs from *H. rubra* in the presence of a groove for the dactylus on the propodus of gnathopod 2 and plumose setae along the palmar margin. The uropod 3 almost similar but the setae on the peduncle is widely spaced, there are two spines apico laterally on the peduncle in the present specimen. The telson in *H. rubra* is with closely set lobes whereas in this present form the telson lobes set apart from each other.

Hyale gopalaswamyi sp. nov. bears striated, spines on the propodus of all pereopods 1 to 5 whereas *H. honolulunensis* lacks these spines and in *H. ayeli* there is only one striated spine on pereopod 2 and one small spine followed by a locking spine on the perepod 5 and normal spines below. Gnathopod 2 in the present specimen shows broad propodus with a dactyl fitting palm whereas in *H. honolulunensis* male form possesses elongated dactylus and the juvenile with normal sized dactylus but groove for dactyl fitting palm is absent and in *H. ayeli* short with a dactyl fitting palm.

Hyale gopalaswamyi sp. nov. resembles *H. guasaye* Barnard 1970 from California in the presence of produced lateral cephalic lobe, presence of locking, striated, corkscrew fashioned spines on the article 6 of pereopods and

differs in the dactyl failing to fit into palm in *H. guasaye* and the 6th article with a hump defining enlarged palm, hump bearing stridulation ridges whereas in the present specimen the 6th article of gnathopod 2 is devoid of the hump with stridulation ridges and the dactyl clearly fits into the palm. The telson in *H. guasaye* with 3 setae on the mid-lateral edge of each lobe whereas in the given specimen only 2 setae are present on each lobe.

Hence it is regarded as new species. The present amphipod is named as *Hyale gopalaswamyi* sp. nov. in honour and memory of the late Dr K. V. Gopalaswamy, former Registrar of Andhra University.

ACKNOWLEDGEMENT

One of us (MRK) is grateful to the Council of Scientific and Industrial Research for financial assistance during the tenure of this work.

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ON A NEW CYPRINID FISH OF THE GENUS *BARILIUS* HAMILTON (PISCES: CYPRINIDAE) FROM ARUNACHAL PRADESH, INDIA[1]

R. P. BARMAN[2]

INTRODUCTION

The cyprinid fishes of the genus *Barilius* Hamilton are distributed throughout India, Pakistan, Nepal, Bangladesh, Sri Lanka, Burma, Thailand, Malaya, China, Egypt and West Africa. Day (1889) recorded 14 species and Jayaram (1981) recorded 16 species under the genus from the Indian region. While revising the subfamily Rasborinae from the Indian region, three examples of a species from Arunachal Pradesh (formerly N.E.F.A.), India referable to the genus *Barilius* were found. When compared with the known species of the genus they proved to be of a hitherto undescribed species. The species is described here and named *Barilius jayarami* after Dr. K. C. Jayaram, one of the pioneer workers on the freshwater fishes of India and Joint Director, Zoological Survey of India, who confirmed the new species.

The new species is apparently related to *Barilius dogarsinghi* Hora and *Barilius infrafasciatus* Fowler but distinctly differs from the latter two species in morphological details.

Material. Holotype (fig. 1): 71 mm in standard length. Reg. No. Zoological Survey of India, Calcutta, FF 2150. Locality: Namdapha Wildlife Sanctuary, Tirap district, Arunachal Pradesh. Coll. Dr. S. Biswas and party. Date of collection : 17.12.1983.

Paratypes. 2 examples, 73 mm-77 mm in standard length; Reg. No. Zoological Survey

[1] Accepted October 1984.

[2] Zoological Survey of India, Calcutta-700 016.

of India, Calcutta, FF 2151. Locality, collector and date of collection same as in holotype.

Diagnosis

Dorsal fin commences opposite interspace between pelvic and anal fin and extending entirely over the latter. Lateral line scales 42-43. Head length 3.70-3.93 and body depth 3.52-3.70 in standard length. Eye diameter 3.00-3.20 in head length, Height of caudal peduncle 2.00-2.40 in its length. Lateral transverse bands vary from 8 to 9.

(1.20-1.60) in postorbital part of head, equal to or slightly shorter than interorbital distance. Gape of mouth wide, extending beyond anterior margin of eye. Two pairs of barbels present, anterior or rostral barbels very short and posterior or maxillary barbels are about one fifth in eye diameter. Height of caudal peduncle 2.18 (2.00-2.40) in its length.

Scales 42-43 in lateral line, 6½ above, 3½ below to base of pelvic fin; 19-20 predorsal and circumpeduncular 14.

Fins: D. ii-iii, 8; A. iii, 11; P. i, 12-13; V. i, 8; C. 19.

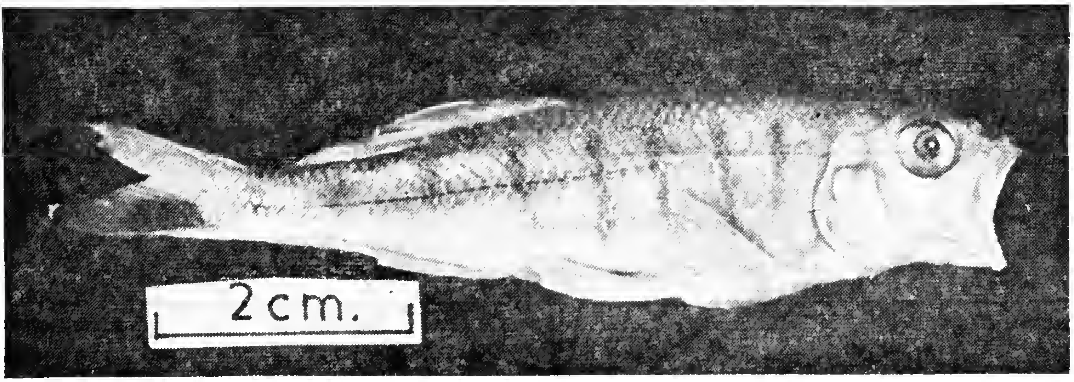

Fig. 1. Lateral view of *Barilius jayarami* sp. nov.

Description

Head length 3.79 (3.70-3.93), body depth 3.63 (3.52-3.70), predorsal distance 1.83 (1.81-1.85), prepelvic distance 2.30 (2.25-2.36), preanal distance 1.56 (1.53-1.59) and length of caudal fin 4.67 (4.50-4.91) in standard length. Height of head 1.19 (1.15-1.23) and width of head 1.99 (1.87-2.12) in head length. Snout length 3.71 (3.40-4.00) in head length, 1.18 (1.10-1.25) in interorbital distance, 1.54 (1.50-1.60) in postorbital part of head. Eye anterior, dorso-lateral, diameter 3.10 (3.00-3.20) in head length, 1.35

Dorsal originates opposite interspace between pelvic and anal, extending entirely over the latter; nearer to base of caudal fin than to tip of snout. Pelvic nearer to tip of snout than to base of caudal fin. Pectoral fin well extending pelvic which reaches anal fin. Height of dorsal 5.39 (4.84-5.90), height of anal (6.73-7.00). pectoral length 5.51 (5.36-5.72) and pelvic length 5.05 (4.91-5.25) in standard length. Caudal fin deeply forked with unequal pointed lobes lower one slightly longer than upper one.

Different body proportions, their range and mean have been shown in table 1.

TABLE 1

Body Proportions	Range	Mean
Standard length/Head length	3.70-3.93	3.79
Standard length/Body depth	3.52-3.70	3.63
Standard length/Predorsal distance	1.81-1.85	1.83
Standard length/Prepelvic distance	2.25-2.36	2.30
Standard length/Preanal distance	1.53-1.59	1.56
Standard length/Caudal fin length	4.50-4.91	4.67
Head length/Height of head	1.15-1.23	1.19
Head length/Width of head	1.87-2.12	1.99
Head length/Snout length	3.40-4.00	3.71
Interorbital distance/Snout length	1.10-1.25	1.18
Head length/Eye diameter	3.00-3.20	3.10
Standard length/Height of dorsal	4.84-5.90	5.39
Standard length/Height of anal	6.55-7.00	6.73
Standard length/Pectoral length	5.36-5.72	5.51
Standard length/Pelvic length	4.91-5.25	5.05
Length of caudal peduncle/ Height of caudal peduncle	2.00-2.40	2.18

TABLE 2

COMPARISON OF *Barilius jayarami* sp. nov. WITH RELATED SPECIES

Characters	*Barilius dogarsinghi* Hora	*Barilius infrafasciatus* Fowler	*Barilius jayarami* sp. nov.
Position of anal fin	entirely under the dorsal fin	partly under the dorsal fin	entirely under the dorsal fin
Diameter of eye in head length	4.00–4.75	3.40–4.00	3.00–3.20
Lateral line scales	38–39	41–43	42–43
Coloration			
(a) Lower lobe of caudal fin with a longitudinal band	absent	absent	present
(b) A deep black spot at the centre of the base caudal fin	present	absent	absent
(c) Caudal fin with 3 obscure dark bands	absent	present	absent
(d) A dark longitudinal band over the caudal peduncle and trunk of the body	absent	absent	present
(e) Vertical bars	9–10	10–12	8–9

Colour in alcohol. Dorsal surface dark and ventral surface bright silvery white. Along the lateral sides of trunk and caudal peduncle 8 or 9 transverse dark bluish bands, narrower than pale interspaces and extending from back to downwards till below lateral line, those on caudal peduncle shorter, and last as dark blotch at base of caudal fin. The dark longitudinal band in lower lobe of caudal fin is an unfailing character of distinction. A dark longitudinal line extending from base of caudal fin to below commencement of dorsal fin. Dorsal fin provided with dark bands across their rays. Pectoral, pelvic and anal fin dull white colour.

RELATIONSHIPS

Barilius jayarami is apparently related to *Barilius dogarsinghi* Hora (1921) and *Barilius infrafasciatus* Fowler (1934). The new species resembles *B. dogarsinghi* in having anal fin entirely under the dorsal fin, two pairs of barbels and lateral vertical bands 8 or 9. However, it can be easily separated from the latter by the following characters. Eye diameter 3.00-3.20 in former species vs. 4.00-4.75 in the later species in head length; lateral line scales 42-43 vs. 38-39; lower lobe of caudal fin with a longitudinal bar vs. no such bar on the lobes of caudal fin.

The new species can be also separated from *B. infrafasciatus* in having the anal fin entirely under the dorsal fin vs. anal fin partly under the dorsal fin; lower lobe of caudal fin is provided with a longitudinal band vs. caudal fin with three dark transverse bands and a dark longitudinal band present over the caudal peduncle and trunk of the new species vs. no such band is present in the latter species.

A comparison of the new species with the related species is given in table 2.

KEY TO THE INDIAN SPECIES OF THE GENUS *Barilius*

1. Cleft of mouth wide, extending far beyond posterior margin of eye. A well developed symphysical knob on the lower jaw 2
   Cleft of mouth moderate, not extending beyond middle of eye. Symphysical knob absent or ill-developed 3
2. Lateral line scales 88-95. Predorsal scales 38-40 and circumpeduncular scales 22-24 .... *B. bola* (Hamilton)
   Lateral line scales 48-50. Predorsal scales 23-24 and circumpeduncular scales 14 .... *B. guttatus* (Day)
3. Anal fin entirely under the dorsal fin 4
   Part of anal fin under the dorsal fin 5
4. Lateral line scales 38-39. Eye diameter 4.00-4.75 in head length. Lobes of caudal fin without any band ...... *B. dogarsinghi* Hora
   Lateral line scales 42-43. Eye diameter 3.00-3.20 in head length. Lower lobe of caudal fin with a longitudinal band .... *B. jayarami* sp. nov.
5. Body without vertical bands 6
   Body with vertical bands 11
6. Lateral line scales 38-43 7
   Lateral line scales 56-75 10
7. Lateral line scales 38-40. Anal fin rays 14-18 8
   Lateral line scales 40-43. Anal fin rays 11-12. Each scale with a black spot .... *B. bendelisis bendelisis* (Hamilton)
8. Body uniformly silvery ...... *B. evezardi* Day
   Body with rows of spots 9
9. Anal fin rays 14-15. Body with two rows of spots. .... *B. canarensis* Day
   Anal fin rays 17-18. Body with single row of spots .... *B. bakeri* Day
10. Lateral line scales 56-62. Rows of spots absent .... *B. radiolatus* (Gunther)
    Lateral line scales 70-75. Two rows of spots .... *B. tileo* (Hamilton)
11. Lateral line scales 39-46. 12
    Lateral line scales 63-75. 15
12. Vertical bands 8-12. 13
    Vertical bands 14-15. 14
13. Vertical bands 8-9. Body depth 3.32-3.68 in standard length. Barbels absent or rudimentary. .... *B. barna* (Hamilton)
    Vertical bands 10-12. Body depth 5.06-5.36 in standard length. Barbels well developed.

rostral barbels greater than eye diameter... .... *B. vagra vagra* (Hamilton)

14. Lateral line scales 39-40. Anal fin rays 15-17. Body depth 3.27-3.54 in standard length. .... *B. gatensis* (Valenciennes).
    Lateral line scales 43-46. Anal fin rays 13-14. Body depth 4.77-5.22 in standard length .... *B. barila* (Hamilton)
15. Lateral line scale 65. Vertical bands 18-19. Barbels rudimentary. .... *B. menoni* Sen
    Lateral line scales 70-75. Vertical bands 12-13. Barbels well developed. .... *B. shacra* (Hamilton)

ACKNOWLEDGEMENTS

I am grateful to Dr. B. K. Tikader, Director, Zoological Survey of India for laboratory facilities and to Dr. K. C. Jayaram, Joint Director, Zoological Survey of India for confirming the new taxon and for going through the manuscript. I am also thankful to Dr. A. K. Ghosh, Deputy Director and to Dr. P. K. Talwar, Superintending Zoologist for their encouragement and valuable suggestions.

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A NEW SPECIES OF *OPHIORRHIZA* L. (RUBIACEAE) FROM KERALA STATE, INDIA[1]

K. RAMAMURTHY AND R. RAJAN[2]

(*With six text-figures*)

Ophiorrhiza nairii sp. nov.

O. roxburghiana Wight affinis sed, stipules interpetiolaribus linearibus, adbasim latioribus, bilobatis; foliis ovatolanceolatis, magnioribus, crassis, supra persparsim villosis, infra minute villosis plus dense in nervis; petiolis longioribus; infloreseentia corymbosa; floribus in uterque pedunculo helicoidis; tubo corollae parvioribus; stigmate 2-lobato, distincte lanceolato et fructuobovoido differt.

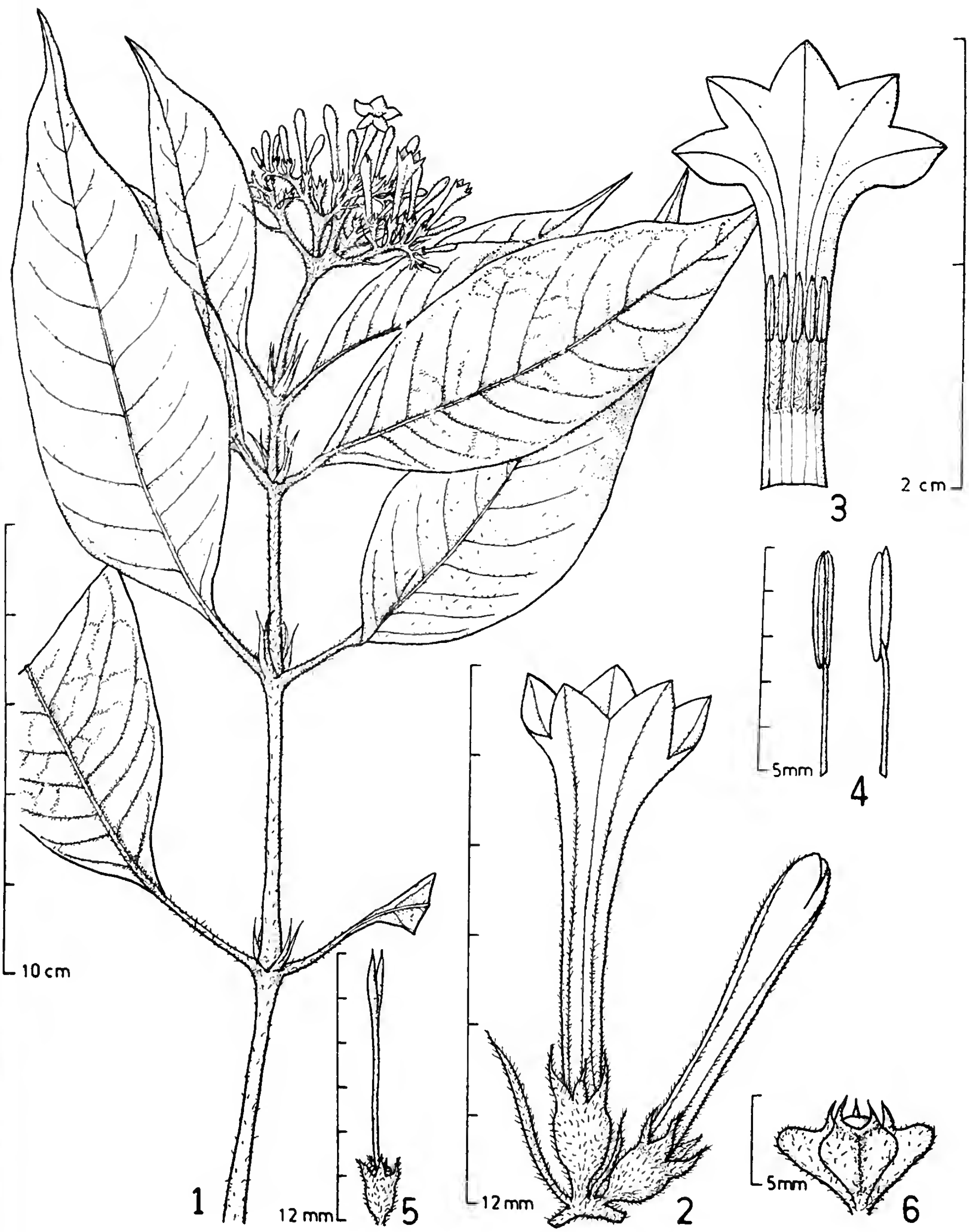
Ophiorrhiza nairii sp. nov.

Allied to *O. roxburghiana* Wight but differs in: interpetiolar stipules linear, broader at base, bilobed; leaves ovate-lanceolate, larger, thick, coriaceous very sparsely villous above, minutely villous below, more dense on veins; petioles longer; inflorescence corymb-like but flowers in each peduncle with distinct helicoid arrangement; corolla tube smaller; stigma dilated into 2 lobes, distinctly lanceolate and fruits obovoid.

Undershrubs; stems erect, branched, terete, densely hairy; internodes 4-12 cm long. Leaves opposite decussate, simple, unequally paired;

[1] Accepted October 1984.

[2] Botanical Survey of India, Southern Circle, Coimbatore-641 003.



Figs. 1-6. *Ophiorrhiza nairii* sp. nov.
1. Portion of a branch; 2. A typical flower and bud; 3. Corolla exposed showing the arrangement of stamens; 4. Stamens; 5. Gynoecium; 6. Typical fruit.

lamina 10-15 × 4-7 cm, ovate to elliptic-lanceolate, acuminate, attenuate at base, leathery, coriaceous, very sparsely villous above, minutely villous beneath, more dense on veins; nerves 10-15 pairs; petioles 1-3 cm long, villous; stipules interpetiolar, 5-12 mm long, linear, broadly at base, bilobed; inflorescence terminal, corymb-like, flowers in each peduncle with distinct helicoid arrangement; peduncles villous; pedicels 2 mm long, hairy; bracteoles many, linear, subulate, hairy. Calyx tube terete, lobes lanceolate. Corolla 1.5-2 cm long funnel shaped above, ribbed, villous within, more dense near the stamens base, less villous without, veins distinct, corolla tube lobbed. Stamens 5, inserted on the corolla tube; anthers oblong, base densely villous, dorsifixed, introrse, dehising longitudinally. Ovary 2-loculed, style filiform, hairy; stigma dilated into 2 lobes, distinctly lanceolate. Fruits obovoid, pilose.

Holotype *Ramamurthy* 66561, (CAL) and isotypes *Ramamurthy* 66561, (MH ACC. No. 127789 to 127793) were collected at Adimali Reserve forest, Idukki District, Kerala at an altitude of 1800 m on 28-3-1980.

The specific name is given in honour of Dr. N. C. Nair, D. Sc., Joint Director, Botanical Survey of India, Southern Circle, Coimbatore for his valuable contribution to Indian Botany.

ACKNOWLEDGEMENTS

We wish to express our thanks to the Deputy Director, Botanical Survey of India, Central National Herbarium, Howrah for his valuable comments on this taxon. Our thanks are also due to Dr. V. J. Nair for latin diagnosis, Dr. A. N. Henry, Regional Botanist for his valuable suggestions, to the Director, Botanical Survey of India, Howrah and Joint Director, Botanical Survery of India, Southern Circle, Coimbatore for their constant encouragement during this investigations. We are also thankful to Mr. K. Sivanandan, Artist, for the illustration.

REVIEW

FLORA OF KARNATAKA. By Cecil J. Saldanha (with the help of S. R. Ramesh, B. R. Ramesh, B. Gurudeo Singh, M. S. Eshwar Rao, B. Ajayakumar and Uday Kumar) — Vol. I (Magnoliaceae to Fabaceae) pp. xi+535 (24 cm × 16 cm) with 3 maps, 62 figures and 19 coloured plates (1 unnumbered + 1–18). New Delhi, 1984. Oxford & IBH Publishing Co. Price not mentioned.

This is the second state flora published after the formation of linguistic states in India; the first being "Flora of Gujarat state" by Professor G. L. Shah of Sardar Patel University, Vallabhvidyanagar. Both these authors are products of Blatter Herbarium, St. Xavier's College, Bombay.

According to the information made available in the introduction, the book is expected to cover all 19 districts of Karnataka and will be completed in three volumes and will include details of about 3410 native angiosperms out of which about 1050 belonging to 315 genera and 64 families have been incorporated in this first volume, 946 species and intraspecific taxa are described in full text, while remaining about 120 are found in cultivation which are just mentioned after their generic and family accounts.

816 species out of the 946 described in full text are found in "Flora of Madras Presidency" by G. S. Gamble (and C.E.C. Fisher), another 30 species have been mentioned from North Kanara by Theodore Cooke in "Flora of Bombay Presidency" and some more have been reported by several other authors. 65 species are included in the flora without any exhiccata and seem to have found place in the flora only on the earlier reports. No mention in the text is found regarding their possible misidentification or possible loss of the species from their original habitats.

The book reveals that 213 species from Gamble's Flora have undergone nomenclatural changes and have been brought upto-date in the present work. Many of these changes however have already been effected in several other works like "Flora of Mysore", "Flora of Bangalore" and the author's own "Flora of Hassan District". Out of 62 plates of figures given in the book, 40 are reproduced from earlier work on "Flora of Hassan District".

The Flora has been completed in a record time of four years and due to hasty compilation lacks in many things as compared to the 'Flora of Hassan District'. Collections definately are not exhaustive enough and the reasons for this according to the author is the termination of the help of scientific assistants from time to time. No team member from the 'flora of Hassan District' is associated with the present work. There is also substantial lack of collaboration with the Botanical Survey of India, in a work of this nature.

The flora does not account for all earlier published works on floristics in Karnataka which is obvious from omissions of the following data which is available at hand for comparison:

1. *Hibiscus cancellatus* Roxb. var. *fusiformis* Hook. is reported from North Kanara

(Bull. Bot. Surv. India 2 : 170, 1960).

2. *Sida schimperiana* Hochst. is reported from North Kanara (Journ. Bombay nat. Hist. Soc. 34 : 628, 1930).

3. *Piper crenulatibracteatum* C. DC. is reported from North Kanara (Repert. Spec. nov. Reg. Veget. 10 : 521-2, 1912).

4. *Cerasiocarpum bennettii* (Miq.) Cogn. [= *Kedrostis courtalensis* (Arn.) Jeffrey] is also reported from North Kanara (Rec. Bot. Surv. India 17: 167-8, 1959).

5. *Diospyros kanjilalii* Duthie is described from North Kanara (Indian Forester 31 : 307, 1905).

The work is not upto-date in field observations. There are hardly any original field notes which add to the present knowledge regarding plants of the region. Routine repeated information from earlier works has made the book monotonous. As an example, it would not be out of place to mention that *Pilea microphylla* (Linn.) Liebm. which is reported in the flora as a cultivated garden plant and weed in cultivated fields, was collected from Agumbe, along road-sides, near sunset point growing on walls and embankments in enough quantity to study its chemical constituents.

In taxonomical presentation of the flora citations of nomenclature should be complete and self-explanatory. As far as possible all names mentioned in the synonymy should have their basionyms for correct judgement of the nomenclature. In a number of cases names cited in the synonmy are without basionyms:

1. *Neolitsea foliosa* (Nees) Gamble var. *caesia* (Meissn.) Gamble.

2. *Lepisanthes umbellata* (Linn.) Raf.

3. *Alternanthera ficoidea* (Linn.) R. Br. var. *pettziakiana* (Regel) Baker.

4. *Caesalpinia paniculata* (Lam.) Roxb.

5. *Erythrina variegata* Linn. var. *orientalis* (Linn.) Merrill.

6. *Rhynchosia albiflora* (Sims) Alston

Cinnamomum travancoricum Gamble is reported on authority of Kamathy & Rao, from Biligirirangan Hills; but no reference is cited and no exhiccata mentioned. In such cases at least a citation should be given for reference to original paper, for consultation. (see p. 62).

Ranunculus subpinnatus Wt. & Arn. In the distribution it is mentioned that this species is reported by Blatter (JBNHS 18: 396, 1908) as *R. diffusus* DC. It is not clear whether the identification of the species was wrong or *R. diffusus* DC. is synonymous with the taxon. (see p. 91).

Cinnamomum zeylanicum Garc. ex Blume is placed in synonymy of *C. verum* J. S. Presl. Nomenclature given in the flora does not reveal information about who unites these two taxa. Second reference, in this case is essential to show who merges these two taxa. [see p. 62 and also p. 361 — *Kalanchoe pinnata* (Medik.) Kuntze].

It is not clear from the nomenclature of *Beilschmiedia wightii* [Bentham] Hook. f. whether *Haasia wightii* Nees is used as a basionym in new combination or considered as a new name.

Phoebe paniculata Nees (1936) (pro parte) has priority over *P. wightii* Meissn. (1964). Nomenclature is not clear whether the synonym here excludes the type which may be the cause of its rejection.

Cyclea peltata (Lamk.) Hook. f. & Thomas. — This name involves Article 55.2 of International code of Botanical Nomenclature. It is necessary to cite "Excl. descr." after the reference. (p. 98).

Meliosma simplicifolia (Roxb.) Walpers ssp. *simplicifolia*: Beusekon is given as the author of the sub-species. As per the rules of ICBN when a species is divided into intraspecific taxa, the typical intraspecific taxon is to be

retained under the same epithet as that of the species and the authority goes to its original author only. (p. 102).

Pilea wightii Weddell (1854): The *synonym Pilea radicans* Wt. (1853) seem to have priority over the accepted name.

Notes given after taxonomic treatment, in many cases, are unwarranted if the nomenclature is self-explanatory:

1. Note under genus *Bauhinia* does not justify acceptance of wider connotation and hence was unnecessary. (p. 376).

2. Note under *Crotalaria pallida* Ait. is unnecessary, since the nomenclature is self-explanatory.

3. Note under *Glycine wightii* Verdcourt. is unnecessary. Lackey's treatment if unacceptable should be shown in the synonymy (p. 466).

4. Note after *Mezoneuron cucullatum* (Roxb.) Wight is only partly correct. Although Vidal & Thol have used *Mezoneuron* as a sub-genus for purpose of classification they have merged the genus in the synonymy of *Caesalpinia* Linn. The authors, in fact, have failed to justify retention of *Mezoneuron* Defontes as a distinct genus.

The printing of the book is excellent but some typographical errors have remained in the text:

Page 67. *Litsea chinensis* Lam. (1972 should be 1792).

Page 81. *Aristolochia bracteata* Lam.— After Santapau "and Wagh" should be added.

Page 96. var. *hirsuta* should be block letters.

Page 376. In note under *Bauhinia*— Instead of distinct species, it should be distinct genera.

The reader's special attention is invited to check on following points and references:

1. *Nyctanthus arbor-tristis* Linn. is placed Nyctaginaceae. Reference to this treatment should have been highlighted (See Proc. Ind. Acad. Sci. 93(3): 349-58, 1984).

2. *Garcinia spicata* (Wt. & Arn.) Hook. & *Butea superba* Roxb. (See discussion by S. M. Almeida, in Proc. Symposium held at Dehradun, pp. 182-5 (1983), Edited by S. K. Jain & R. R. Rao).

3. *Mammea suriga* (Buch.–Ham. ex Roxb.) Kosterman. This is an illegitimate name based on illegitimate basionym.

4. *Canavalia rosea* (Sw.) DC. (See Chatterjee, J. Ind. Bot. Soc. 28 : 87, t.D, 1949).

5. *Hydnocarpus laurifolius* (Dennst.) Sleumer (See Taxon 10 : 80, 1961 & 17 : 496-503).

6. *Cucumis melo* Linn. is reported at two places (pp. 296 & 307). Similarly *Trichosanthes cucumerina* Linn. var. *anguina* (Linn.) Hains is also mentioned at two different places (pp. 304 & 308).

M. R. ALMEIDA

MISCELLANEOUS NOTES

1. AN "ISLAND" SANCTUARY IN KUTCH

The concept of conservation of island ecosystems as geographical and ecological entities often holding unique, endemic and rare species of fauna and flora in a circumscribed and threatened environmental situation, has been increasingly accepted in the past two decades. There has been an effort to identify and set apart islands for science and as repositories of genetic resources. Since the last 10 years an effort has also been underway to identify and effectively protect areas in the mountain, marine and desert areas.

The country has made a headway in establishing a desert national park in Rajasthan and the Little Rann of Kutch sanctuary in Gujarat. Mountain parks are being set up in the Himalaya. However, the concept of island conservation has not made much progress.

In the case of Kutch there are more than one conservation area which has the ingredients of both desert and arid biotopes, and an island situation. Both in the Little and the Great Rann of Kutch there are outcrops which rise from and are surrounded by the great saltpans of the two Ranns. They are complete geographical entities separated from the "mainland" of Kutch and Saurashtra and have all the attribute of island ecosystems except that during the major portion of the year (excluding the rainy period and its immediate aftermath) they are separated from the mainland not by a sheet of water but by an expanse of flat saltpans. During the monsoons, fresh water from the rains and the rivers and the salt water coming in from the sea, make these outcrops islands in the true sense of the term.

The "islands" in Little Rann — Mardak, Kesmaria, Pung and others are rather small and being stopover places of cattle moving between Kutch and Saurashtra, are subjected to demographic pressures and are not very viable areas of conservation on their own, though, of course, they are extremely important concommitants of the Little Rann of Kutch where they provide refuge to the wild ass (*Equus hemionus khur*) and other desert fauna, specially during the rainy season. They are also very important from a geological standpoint.

However, from the viewpoint of viable ecological areas of conservation we must turn to the much larger islands in the Great Rann of Kutch. On the southern flanks of the Great Rann of Kutch are two great projections of the habited "mainland" of Kutch -- Bela and Pachcham. Both, however, are not true "islands", being connected with strips of arid lands higher than the saltpan of the Rann. They are in fact 'peninsulas' and not islands. They are both important from the defence standpoint, are fairly extensively inhabited and an aerial survey carried out from a helicopter in January, 1984 revealed that their rangelands are being fairly extensively used and have deteriorated, more so in Bela than in Pachcham.

The same aerial survey revealed a different picture for the island of Khadir and the adjacent small islands around it. Khadir is the

largest true "island" in either of the two Ranns of Kutch. It comprises of a high rising ridge running east to west and providing a very impressive precipitous feature viewed from the north, towering as it does over the Great Rann. Southward, the escarpment slopes gradually and is covered with climax desert flora — *Acacia senegal, Acacia specigera, Acacia nilotica, Prosopis cineraria, Zizyphus nummularia, Capparis decidua.* The introduced *Prosopis juliflora* which has overrun Pachcham, Bela, the Banni and almost the entire borderlands of the two Ranns, has not yet pervaded Khadir for the reason that it is still clothed with its original flora.

On the southern flanks of Khadir and on the small "islands" which are adjacent to it here, we saw from the helicopter 36 wild asses and the only chinkara (*Gazella dorcas christii*) during our entire aerial perambulations over Kutch. It holds populations of nilgai (*Boselaphus tragocamelus*) and of the wild pig (*Sus scrofa*). On a fresh water lake on Khadir, we saw large flocks of Demoiselle Crane (*Anthropoides virgo*), and a few Eastern Common Crane (*Grus grus*). The habitat seemed ideal for partridges (*Francolinus* sp.), quails (*Coturnix*, and *Perdicula* sp. Common, Spotted, and painted sandgrouse (*Pterocles* sp.), the desert hare (*Lepus nigricollis dayanus*), the wolf (*Canis lupus pallipes*), the jackal (*Canis aureus*), the Indian and desert foxes (*Vulpes bengalensis* and *Vulpes pusilla*) and other desert and arid land fauna. Of special significance amongst the birds is the spotted sandgrouse, which is getting very rare and localised. It harbours the houbara (*Chlamydotis undulata*) as a winter visitor. The habitat appeared to be an ideal one for the conservation of that most endangered feline, the caracal (*Felis caracal*) and may well be perhaps the most suitable area for the preservation of this threatened cat in the whole country. It, of course, is the habitat of another endangered feline, the desert cat (*Felis libyca*) and could well be a suitable place for the reintroduction of the Asiatic Cheetah (*Acinonyx jubatus venaticus*) if ever an endeavour is made to reintroduce this animal in India. From the air we also saw a pair of foxes which answered closely to the description of Blandford's fox (*Vulpes cana*) about which a separate note has been submitted to the *Journal*.

To the north-west and west of Khadir, including the wide belt of the Rann between Khadir and Pachcham is a vast tract of the Rann slightly lower than the continuous saltpan. Here the water accumulates and stands and with the process of evaporation turns gradually more saline. In this terrain in the past the Bombay Natural History Society led by Dr. Sálim Ali rediscovered nesting colonies of the Greater flamingos (*Phoenicopterus ruber*) and of the rosy Pelicans (*Pelicanus onocrotalus*). This area, therefore, is of special significance to the Bombay Natural History Society. In the last three or four years, however, there is no report of flamingo breeding here. This could be due to a number of reasons, but the aerial spraying of pesticides on Pachcham and other islands in the vicinity to kill the locusts a few years back, which resulted in the dead locusts as well as the pesticide draining into and accumulating into this inland drainage area, may well be a contributory factor. However, it is very likely that in the years to come the flamingos will breed once again in this their traditional breeding ground.

It is recommended that the entire Khadir island together with its adjacent smaller islands and portions of the Great Rann of Kutch around it should be declared as a wildlife

sanctuary and effectively protected. The headquarters of the sanctuary should be established in the largest village of Khadir. In the north and northwest of Khadir the sanctuary boundary should extend up to at least 25 kms from the edge of Khadir island. Westwards the sanctuary boundary should be along the edge of Pachcham where it meets with the Great Rann. Eastwards, it should be along the edge of Bela and Gangtabet, where the Rann meets with Bela and Gangtabet, southwards and southeastwards the sanctuary boundaries should be at least 20 km from the southwestern edge of Khadir.

I have been a regular visitor to Kutch from 1954 to 1961 and had travelled extensively in this vast expanse of fascinating terrain so rich in the fauna and avifauna of the arid region. It was one of the last and greatest havens for wildlife and of nature, albeit of an arid kind, in our subcontinent. After a lapse of precisely 23 years I was able to revisit some of the areas and to see new ones from the air. Flying low from a helicopter it was easy to see what was happening. The desert biotope of acacia species had been decimated and the exotic *Prosopis juliflora* was fast taking over in most parts. In others the land lay barren. The rich grasslands specially those of Banni were obviously overgrazed, criss-crossed with innumerable cattle trails and were fast becoming dust bowls. Where the wolf (*Canis lupus pallipes*) was common and met with almost every day in the wilder tracts of Kutch, we saw not a single sign from the air and they are now reported to be very rare. Of the Chinkara, which I have seen more than 400 in the course of a day's outing in the past, we saw but five specimens all around Khadir, in our entire flying time of almost five hours. To save the representative original fauna and flora of Kutch, indeed of the entire arid and semi-arid western India and of the Thar desert, together with remnant, rare and threatened populations of fauna as well as to safeguard the only known traditional breeding ground where flamingoes have been known to breed in large colonies in the recent past, it is imperative that the area earmarked and discussed above, encompassing the whole of Khadir "Island" and its neighbourhood and covering certain portions of the Great Rann, be declared a wildlife sanctuary. If, thereafter, it is found feasible, the area of the sanctuary could be extended to cover portions of Pachcham, a greater portion of the Great Rann and could even extend up to that unique area of inland drainage and semi-brackish water called Chhari-no-Dhand, and the Banni grasslands.

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THE PALACE,
WANKANER, SAURASHTRA,
February 3, 1984.

2. A NOTE ON THE SCAVENGING BEHAVIOUR OF STRIPEDNECKED MONGOOSE ON TIGER'S KILL

Stripednecked mongoose *Herpestes vetticollis vetticollis* Bennet has been seen in the grasslands, adjacent forests and near the lake shore in Periyar Tiger Reserve.

A dead male specimen of the animal which was found on the lake shore near Mullakkudy had the following characters. The coat colour was chestnut and a prominent black stripe

extended from behind the base of the pinnae towards the shoulder. The distal end of the tail was black.

Very little is known about the feeding habits of this largest Asiatic mongoose though they are said to feed on frogs, fishes, crabs, fruits and roots (Prater 1965). A stripednecked mongoose was reported seen chasing a young chital fawn (Krishnan 1975). On 24th October 1979 during our field studies at Periyar I and my colleagues were sitting on a tree at about 20 m away from an approximately 2 days old tiger's kill of a sambar stag. At about 2 p.m. in the afternoon two stripednecked mongoose came to the kill which was lying among grass. One mongoose came to the carcass and tore about half a kilogramme of sambar meat with its mouth and carried the same in its mouth to a nearby bush. The other mongoose followed it and both started feeding on the meat. This observation was made through binoculars.

It is quite interesting to note that the mongoose are mostly diurnal. In the case of tiger's kill under observation the tiger came to it during the subsequent two nights.

This scavenging behaviour of stripednecked mongoose brings to light the animals' varied habits.

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3. A NOTE ON THE BEHAVIOUR OF CAPTIVE DHOLES (*CUON ALPINUS*)

(*With two plates*)

Recent reviews of existing knowledge concerning the dhole, or Asiatic wild dog (*Cuon alpinus*), have highlighted the need to begin both ethological and ecological studies of this threatened carnivore (Davidar 1975; Cohen 1977, 1978). A major contribution to dhole ecology has been made by Johnsingh (1979) but little is known of the behaviour patterns utilized by dholes and their relationships to those of other canid species. Although the observations reported here were made over a short time period, under less than ideal conditions, they represent one of the first attempts to study the behaviour of this species and may therefore be of interest.

Data were collected between 0900 and 1600 hrs from 10 to 12 March 1978, on two groups of adult dholes housed at Duisburg Zoo, Duisburg, West Germany, which has been breeding them in recent years (Gewalt 1978). Group A, maintained in an enclosure 5×7 m, consisted initially of three siblings born 17 March 1975. This included one male (♂A) and two females (♀ A-3 and ♀ A-4). Female

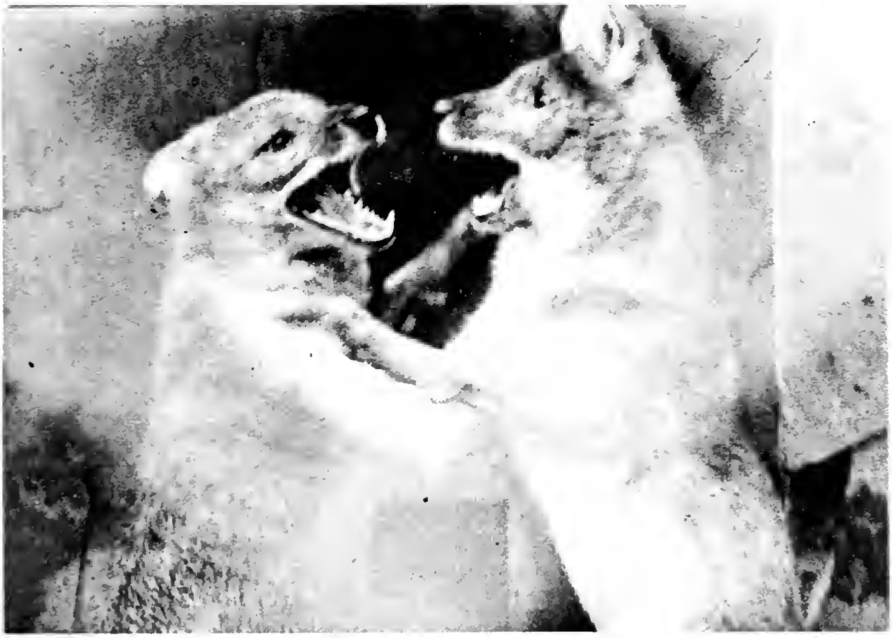
A-3 had lost one forelimb at the age of one month, but this had healed well and she appeared to move about the enclosure with facility and to interact socially without handicap (Gewalt 1978). Group B, kept in an enclosure measuring 3×7 m. consisted of one male (♂B; also a sibling of Group A) and one female (♀B). On the afternoon of 10 March, ♀A-4 was removed from the pen for whelping and another adult female (♀A-M), which had given birth on 11 February to a litter sired by ♂A, was returned to the pen in her place. Also at this time, ♀B was locked into her nest area for whelping, and ♂B provided with a new nest-box in the enclosure. These two animals were able to maintain visual, olfactory, and auditory contact through the bars of the female's nest area. Isolation of whelping females has become necessary due to a high frequency of pup-cannibalism in captivity (Gewalt 1978). These alterations in group composition, while not ideally timed for my observations, likely caused some disequilibrium in social organization and may have led to artificially-high frequencies of interaction. This is, however, of some advantage in a short study such as this.

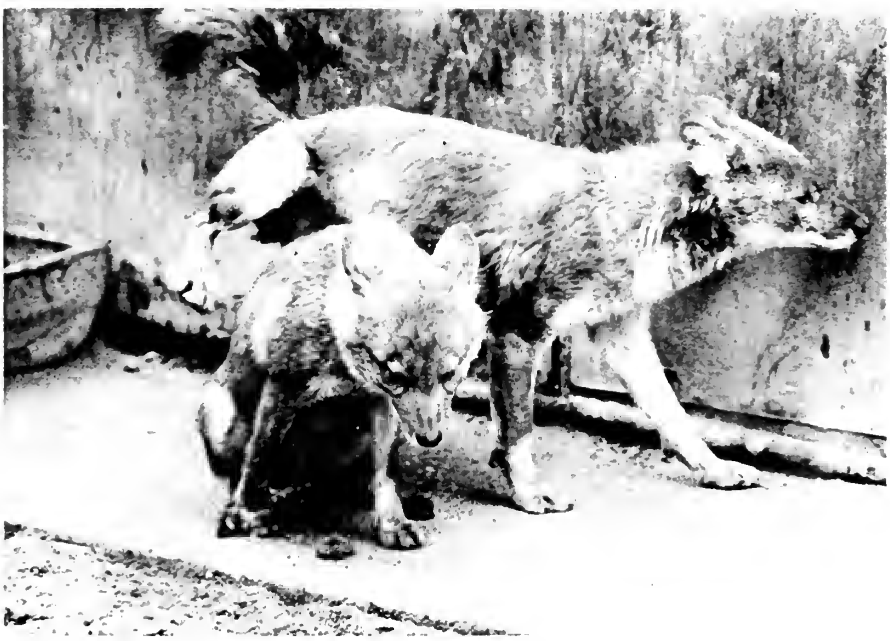
Summary of observations

Davidar (1975) has stated that dholes may growl, whine, howl, and whimper, but did not describe the contexts in which these vocalizations are given. Among the Duisburg animals, whining was heard in the following contexts: by ♀A-3 while actively submitting (see Fox 1971) to ♀A-4, and by ♀B after being separated from her mate. A more excited form of whining, possibly similar to the "twittering" of African hunting dogs, *Lycaon pictus* (Kuhme 1965), was given simultaneously by ♂B and ♀B just prior to entering the nest-area together. High-pitched squealing was occasionally heard while these two animals ran about their enclosure. A sharp "Kak-Kak" was given once by ♂A just before leaping against the wall and rebounding back. Growling was heard during all three of the agonistic encounters observed. The high-pitched whistling sound said to be a characteristic "assembly call" of dholes (e.g. Burton 1940; Krishnan 1972) was never heard. On two occasions the wolves and malamute dogs in nearby enclosures engaged in lengthy group-howling sessions. The dholes did not join in this and seemed to take little notice of it, thus corroborating the report of Sosnovskii (1967).

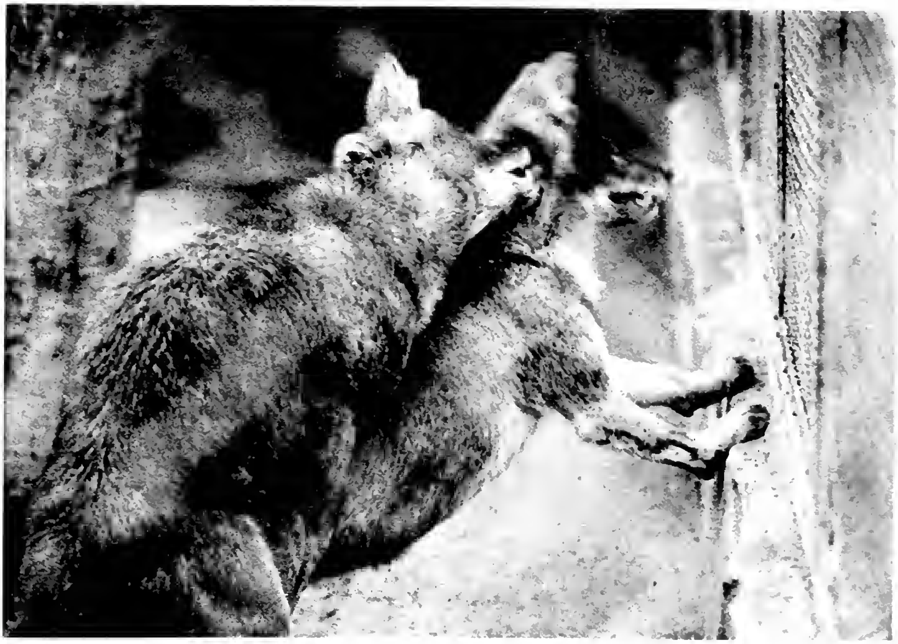
Active submission consisted of the animal lowering its entire body while approaching a conspecific, followed by a further lowering of the shoulders and turning the head approximately 130°, exposing an open-mouth submissive grin (see Fox and Cohen 1977). The submissive animal then licked the dominant animal's lips. An alert posture was characterized by forward-arching ears, vertical tail, and slight piloerection of the nape of the neck. The tail arches forward over the animal's back during aggressive threats. During agonistic encounters both animals may rear up against each other, displaying an open-mouth gape (Plate 1), sometimes accompanied by growling. Such mutual gaping is more characteristic of fox-like, rather than dog-like canids (see Fig. 7b, d in Fox and Cohen 1977). The dominant animal was occasionally seen to display a slight "aggressive mouth-pucker" (Fox 1971), while the subordinate dhole's mouth was open wider. On no occasion, however, were the teeth bared in a "snarl", as is common among other dog-like canids.

Areas seen to be sniffed were the anal region, temporal region, and the lips, suggesting the presence of glands in these areas (see





Above: Agonistic open-mouth gaping; ears flattened in subordinate animal, erect in dominant.
Below: Marking-over.
(*Photos :* Author)



Above: Mounting with scruff-bite.
Below: Head-shake used to "kill" food.
(*Photos :* Author)

also Fox 1971). Feces and urine of all animals in an enclosure were almost always deposited in the same communal location, corroborating the field reports of Davidar (1975) and Cohen *et al.* (1978) regarding "dung-piling". Table 1 shows that while female used the squatting urination posture exclusively, males used both the squatting and raised leg postures. Raised-leg urination was used by ♂A only once during "marking-over" (Plate 1), while the female was still defecating. Male B used this posture only to mark the sides of his newly-installed nest-box, suggesting that raised-leg urination may be a response to either prominent vertical objects in the environment, or simply to novel objects. All contributions to the communal "dung pile" (whether feces or urine) were made in the squatting posture by animals of both sexes. "Marking-over" was defined as one dhole urinating on the feces or urine of a group-mate within 15 seconds after the latter had been deposited. This was done twice by ♂A, three times by ♂B, and once by ♀A-3. Urination in a handstand posture, as described by Keller (1973) was not seen.

Table 1

Frequencies of urination in each of two postures (all observation pooled)

INDIVIDUAL

Posture	♀A–M	♀A–3	♀A–4	♀B	♂A	♂B	Total
Squat	5	14	0	2	8	6	35
Raised-Leg	0	0	0	0	1	9	10
Totals	5	14	0	2	9	15	45

Male A mounted ♀A-4 six times, but on no occasion achieved intromission. All mounts were performed in the typical canid, standing fashion (Kleiman 1968), rather than in the "crouched", feline-like posture reported by Davidar (1973). On two occasions the male bit and held the scruff of the female's neck in his mouth during mounting (Plate 2).

The dholes were usually fed inside their nest boxes where they could not be observed. On 11 March, however, at my request, fresh meat was given to the animals outside in their enclosures. It was at this time that ♂B was seen to tear off a piece of meat and rapidly shake it in his mouth (Plate 2). This is a common canid behaviour used for killing small prey (Fox 1971) and, indeed, in south India small mammals such as lagomorphs and rodents may provide as much as 38% of the dhole's diet (Cohen *et al.* 1978).

A few observations were made of two 8-week old pups (1♂, 1♀), born to ♂A and ♀A-M. These were placed in an arena measuring approximately 150 × 60 cm. Much of the time they walked about the enclosure and reared up against the walls, attempting to climb out. On several occasions the male placed his forepaws on the female's back, biting the scruff of her neck, rapidly shaking his head laterally, and growling. This elicited no apparent response from the female. When isolated from the female, the male pup whined continually.

Discussion

It can be seen even from these limited observations that the dhole is an unusual canid species. It clearly displays a number of behavioural adaptations to a highly social existence, as evidenced by the diverse body, ear, tail, and facial postures, vocalizations, and elimination patterns. It is however, quite distinct from other dog-like canids in its agonistic (mutual gaping) behaviour, "Kak-Kak" vocalization, and apparent lack of a "snarl" display (vertical retraction of the upper lip to display teeth). Indeed, while the dhole has been classified in the subfamily Simocyoninae, together with the African hunting dog (*Lycaon pictus*) and the South American bush dog (*Speothos venaticus*), recent evidence (Clutton-Brock *et al.* 1976) suggests that two of the dhole's three nearest phylogenetic neighbours are foxes of the subfamily Caninae.

These facts help underline how poorly the species is understood and suggest that further research would be both feasible and rewarding. Since captive breeding of dholes has been problematical (Gewalt 1978), a better understanding of dhole behaviour is needed in order to help preserve this unusual endangered species.

Acknowledgements

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4. UNUSUAL USE OF THE TRUNK FOR SOUND PRODUCTION IN A CAPTIVE ASIAN ELEPHANT: A SECOND CASE

In an earlier report we described an unorthodox method of sound production using the trunk by a captive 20 year old sarin (nulliparous cow) named Gyanendra Kali in the Government Elephant Camp of Sauraha, Nepal (Wemmer and Mishra 1982). This particular elephant produces long, penetrating, and eerie whistles by pressing and blowing with the tip of her trunk against the lower lip. As reported, there is good evidence the pattern was learned from an aged and now deceased sarin who had evidently invented the calling method, and with which Gyanendra Kali had been raised.

In 1983 after our report was published another elephant at this camp was found to whistle using a somewhat similar method. This particular elephant (Prithivi Kali) was purchased in 1978 in the Birganj area (Parsa District) of the Nepalese terai, and is estimated by Subbha Ram Lotan to be about 22 years old. This animal whistles by curling the trunk and pressing the tip against the ventral surface to form a tight curl. The sound has the same high pitch as that made by Gyanendra Kali, but is only emitted in short bursts. According to Ram Lotan, the sound was first heard two years after the elephant was purchased, and has become more frequent since then.

Elephants which are tethered nightly in the 'pilkhana' commonly develop individualistic habits such as chain rattling or special sounds. The repertoire of these habits, however, is limited, and the same variants can be seen in different camps. The whistling habit reported herein is distinctive. The occurrence of whistling in these two elephants may be coincidental, a case of observational learning, or an example of sound mimicry. We would be interested in learning of any other similar examples.

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CONSERVATION AND RESEARCH CENTER,
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FRONT ROYAL, VA 22630,
U.S.A.

CHRIS WEMMER

NEPAL TERAI ECOLOGY PROJECT,
P.O. BOX 38,
KATHMANDU, NEPAL,
October 19, 1984.

HEMANTA MISHRA
ERIC DINERSTEIN

5. A FEMALE BLACKBUCK WITH HORNS

(With a photograph)

The photograph of a female Blackbuck (*Antilope cervicapra*) was snapped on 20th May at Velavader Blackbuck National Park, 70 km away from Bhavnagar city in Saurashtra (Gujarat). The picture and the information thereon may be useful to people and students who are interested in the study of wildlife.

Normally female Blackbuck are hornless while the female Blackbuck in the photograph has horns, which is rare in nature. According to local experts she seems pregnant. Judged by the size of horns, she must be 2-3 years old.

In the reference cited in "The Indian Blackbuck Antelope-A Texas view" by Elizabeth Cary Mungall, Blanford (1888-91) saw a horned female near Nagpur. He bequeathed the skull of one to the British Museum (Natural History) (Skull No. 1912. 10.31.26; Lydekker 1913) and about 1909 was accused of shooting the tame horned female that lived in an Indian village.

(*Photo*: author)

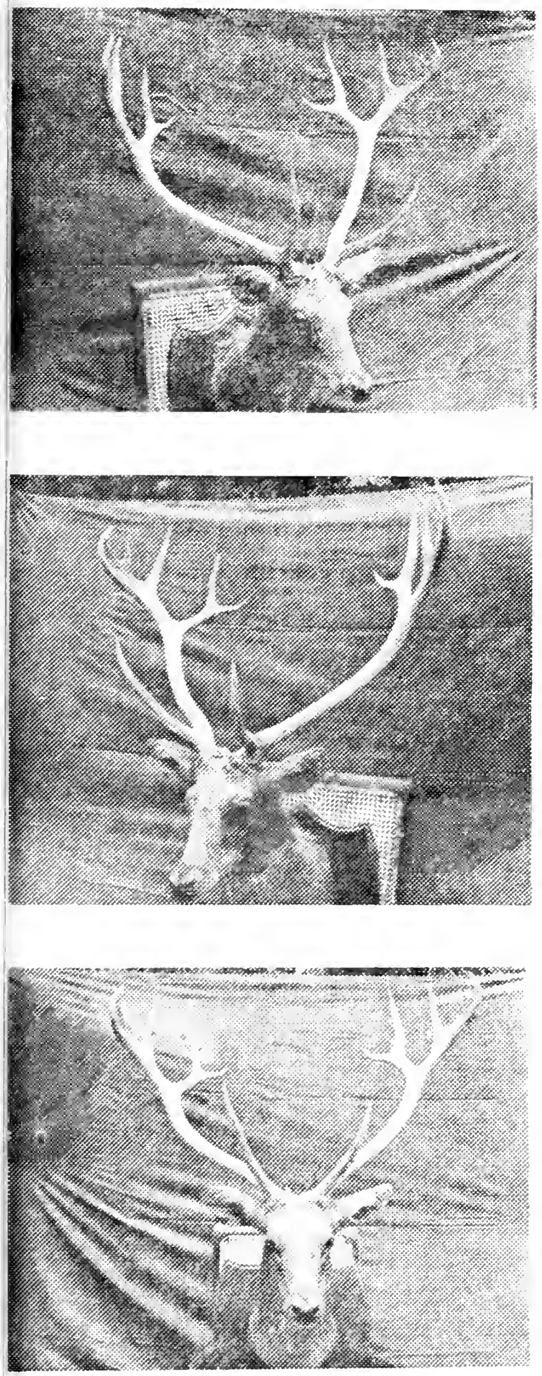
TAKHTESHWAR HILL PLOT,
JAILOR'S BUNGALOW,
KALUBHA ROAD,
BHAVNAGAR 364 002,
May 28, 1984.

D. R. CHAUHAN

6. GEOGRAPHIC VARIATION IN THE BARASINGHA OR SWAMP DEER (*CERVUS DUVAUCELI*)

(With a text-figure)

The article "Geographic Variation in the Barasingha or Swamp Deer (*Cervus duvauceli*)" by Colin P. Groves on page 620 of your esteemed *Journal* Vol. 79, No. 3 is very interesting. One of the differences mentioned about the Assam variety of Swamp Deer is



ig. 1. Swamp Deer head from Nepal forest bor-
ering Mirchia Swamp Deer Preserve, Khairigarh
aj, Kheri Dist., U.P., India.

that the antlers are palmated whereas in the Kheri/Nepal variety the antlers are not palmated. In this connection I would like to mention that palmation in the antlers of Swamp Deer is not unknown in the Kheri/Nepal variety. I am enclosing three photographs of a trophy in our collection which shows palmation clearly; this specimen was shot by my father the late Yuvraj Diwakar Prakash Singh in 1938 in the Nepal forest bordering the famous Mirchia Swamp Deer Preserve of Khairigarh Raj, in District Kheri, U.P., India, and was mounted by Van Ingen and Van Ingen, Mysore. Palmation occurs in other Indian Deer species as well. An example is the photograph of a Sambar antler which appears in the B.N.H.S. *Journal* Vol. 27, No. 1, July 1920, in the article, "Abnormal Sambhar Horn" on page 170, in the Miscellaneous Notes section. In the "Hangul" Kashmir Stag also palmation is not unknown. If indexes of old *journals* are checked, it is possible that other examples might find mention under headings like "Abnormalities in deer Antlers" or "Palmation in Deer Antlers" etc. A study of the *journal* records might throw light on this question

As for the other characteristics mentioned by Colin P. Groves in his article he himself mentions that "while none of the differences by itself quite reaches the conventional level of subspecific differenciation (75% rule)...." on page 623 and in the Notes on page 626 he regrets the small number of specimens for comparison. It would, therefore, be expedient to truly identify this new subspecies by thorough study before coming to a final conclusion. As collecting specimens of rare fauna is not possible in the interest of preservation of the species, I would suggest:

(a) Photographs be taken of the males with powerful telephoto lenses after approaching them on elephants as close as possible or from machans, if the herds are near them at particular times of the day.

(b) In the season when the antlers are shed if a watch is kept on the herds, the likely areas where the antlers are dropped could possibly be identified and then if the area is dry, a line of men like beaters could be employed to scrutinize the area to pick up the shed antlers.

(c) The old Clubs, Army messes, residences of Tea Estate Managers and residences of gentry, who were fond of hunting formerly would also surely have numerous Assam Swamp Deer trophies which could be studied.

The National Park staff at Kaziranga (Assam) would have the knowledge and be in a position to help methods (a) and (b).

KASMANDA HOUSE,
2, PARK ROAD,
LUCKNOW, U. P.,
June 23, 1984.

RAJA DINESH PRATAP SINGH

Raja D. P. Singh's letter is very welcome, supporting as it does both the letter and the spirit of my paper.

That a particular population has been designated as a separate taxonomic entity, such as a subspecies, is often a crucial factor in awarding it formal protection: "our unique subspecies..." etc. There is of course good reasoning in this: preservation of a unique gene-pool is one of the most important goals of the conservation movement. Yet, and here is the irony, in order to demonstrate that the population actually is distinct, warranting formal taxonomic designation, it is necessary to have a series of specimens for study; if such specimens are not already available, it is hardly appropriate to go out and shoot some — diametrically opposite to what one is trying to achieve!

Raja Singh's suggestions are the only really feasible alternative. Wildlife photography has for some time now been in the position of a potent taxonomic aid, in just such a fashion: indeed, M. K. Ranjitsinh's photographs, published as part of my paper, are possibly more useful in illustrating the points I was making than are my own of museum specimens. Again, with deer we are unusually lucky, as in cast antlers we have voucher specimens obtained in an ideal, conservationist, manner.

As for Raja Singh's point (c), I did try to find old trophies throughout India, by means of letters to newspapers; on the basis of the response I got, I made a four-month tour of India in early 1979. Undoubtedly, though, there are many more in odd corners: nobody could tell me of any trophy collections in the eastern states (Assam, Bengal etc.), which I therefore did not visit. So any news of such collections — of any species, not only of deer — would be very welcome.

THE AUSTRALIAN NATIONAL UNIVERSITY,
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August 17, 1984.

COLIN P GROVES

7. AN ADDITIONAL RECORD OF THE LEAST FRIGATE BIRD *FREGATA ARIEL* IN INDIA

A pelagic bird was picked up during the monsoon on the seashore near Quilon town, and has been an exhibit at the Museum of the Shree Narayan College for Men at Quilon for several years. It was evidently a frigate bird but it did not agree with any of the descriptions in the literature available and I mentioned this to Mr. Humayun Abdulali. At his instance, Dr. S. Ramachandran, Head of the Department of Zoology of the College had the mounted specimen packed and sent to the Bombay Natural History Society where it was photographed and the measurements (left wing 556 mm, other damaged, tail 310 mm, fork 119 mm, bill from feathers 85 mm) sent to Dr. S. D. Ripley of the Smithsonian Institution. It has been identified as the Least Frigate Bird (*Fregata ariel*) in juvenile plumage in which the chin, throat and upper breast are white, bordered by a dark head and a white belly.

The type locality of the only subspecies accepted in India *F. a. iredalei* Mathews is Aldabra Island, off the east coast of Africa and a juvenile ringed at that place was found washed up on the beach near Bombay in June 1970 (Rauf Ali, *J. Bombay nat. Hist. Soc.* 67: 569). The present, apart from several from Ceylon is the fourth record from Indian limits, and all of them have presumably been brought in by the Southwest monsoon.

J. B. Nelson (1976, *Living Bird* 14: 113-155) has reported a prolonged breeding cycle and long deferred maturity in frigate birds. It takes more than twelve months to accomplish a single breeding cycle and the period of immaturity is carried up to six years. At least three of the four specimens found in India had white underparts. Would it be possible that the majority of specimens are in this plumage?

I am indebted to Dr. Ramachandran and Mr Abdulali for the trouble which they took and to the Charles McCann Vertebrate Zoology Field Work Fund at the Bombay Natural History Society for meeting the not inconsiderable expenditure of packing, transport and photography.

P. G. DEPT. OF ZOOLOGY,
THE NEW COLLEGE,
MADRAS 600 014,
July 28, 1983.

S. FAIZI

8. CHICK-FEEDING IN IBISES AT KEOLADEO NATIONAL PARK, BHARATPUR

After early intensive foraging, an ibis generally returned to its nest and regurgitated its crop contents either on the nest floor or directly into the chick. HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, mentions that in ibises the food is not picked up from nest floor as in storks', but on 6th September 1982 around 7.30 a.m., during a nest-bird count by boat in the Sapan Mori Heronry, at Keoladeo National Park (Bharatpur), I observed a White Ibis (*Threskiornis aethiopica*) regurgitating food on the nest floor (in a manner simi-

lar to neighbouring Openbill Storks and Median Egrets) and the hungry circle of nestlings 'fell to' very noisily. On another nest, the parent rested a while after alighting and shook out food into the chick, only after the chick forced an entry into its gape. This procedure was repeated more than six times after arrival of this bird.

USHA BHUTIA

BOMBAY NATURAL HISTORY SOCIETY,
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BOMBAY 400 023,
October 19, 1983.

9. SIGHTING OF WHOOPER SWANS (*CYGNUS CYGNUS*) IN BALUCHISTAN

According to Volume 1 of HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN[1] there are only a dozen records of the sighting of this swan in the subcontinent since 1829 and no records within the last thirty years. The exact subspecific identification of the birds recently sighted cannot be determined, but by reference to a standard field guide[2] which I had taken with me, the pattern of their bill corresponded exactly with that of the illustrations of the Whooper Swan, not of the Bewick's Swan (*Cygnus cygnus bewickii*).

Following a report from Mr Inayatullah Arbab, Sub-divisional Forest Officer, Wildlife, Quetta that three 'Swan' had been sighted in the winter of 1981/82 on the Lake Zangi Nawar in southwestern Baluchistan, the writer made a personal visit early in 1983. On February 7th and 8th 1983, eight Whooper Swans (*Cygnus cygnus*) were watched through 10 × 50 binoculars at a distance of less than 150 metres. It was reported that they had been on the lake for more than a month.

Zangi Nawar is the second largest natural lake in Baluchistan, an arid region which is practically devoid of any other significant wetlands. It lies approximately 50 kilometres west of Nushki, the principal town in Chaghai District in southwest Baluchistan. The exact location is 29°25′ N. and 65°47′ E. The lake is a perennial body of water and resulting from recent above-average rainfall covered approximately 1000 hectares at the time of my visit. It is formed by drainage from a 'Lora' (non-perennial channel) which flows in a southwesterly direction from the Seistan basin in Afghanistan. The lake itself is separated into lagoons by sandhill ridges and fringed by low bushes of *Tamarix troupii*. It is dotted with a few stands of reeds and sedges in the deeper parts, including *Phragmites*, *Carex* and *Juncus* species. It is not much more than 3 meters deep at its deepest part. In winter it is a resort of large numbers of migratory waterfowl, the Common Coot (*Fulica atra*) being the dominant species, but there are also numerous dabbling ducks.

[1] ALI, SALIM & RIPLEY, S. DILLON (1968): A Handbook of the Birds of India and Pakistan. Vol. 1. Oxford University Press, Bombay, p. 136.

[2] HEINZEL, H., FITTER, R. & PARSLOW, JOHN (1972): The Birds of Britain and Europe with North Africa and the Middle East. Collins, St. James' Place, London. pp. 44-45.

WILDLIFE MANAGEMENT SPECIALIST,
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ASHIQ AHMAD

10. INDIAN BLACKCRESTED BAZA (*AVICEDA LEUPHOTES*): A SIGHTING RECORD FROM KARNATAKA

On 10-xi-1983, I was in Agumbe State Forest (Shimoga Forest Division; locality, Mallandur) on the ridge of the Western Ghats in Karnataka State. During the course of a survey to locate troops of Liontailed Macaques, driving along a forest track, in a large clearing in dense evergreen forest, I saw two pigeon-sized birds of prey in striking black-and-white plumage alight on a *Ficus* tree. Getting down from the vehicle, I was able to approach on foot to within 30 metres of them and had a good look through 8 × 50 binoculars. I was able to positively identify the birds as Indian Blackcrested Bazas.

According to Ripley (1982) this bird is a resident in the foothills of Kerala. According to Ali and Ripley (1968), it is described as uncommon and recorded only from Kerala, Wynaad and Nilgiris, though they speculate on its occurrence in western Karnataka. My sighting record confirms this speculation and extends the recorded northern range of *A. leuphotes* to lat. 13°15′ N. Evergreen forest habitats similar to those in Agumbe extend further northwards up to Jog Falls (lat. 14° 16′ N) and it is likely that this Baza occurs there also. Incidentally in the last 20 years of birdwatching in Karnataka, this is my first sighting of this Baza which is perhaps an evidence for its rarity.

499, J. T. EXTENSION,
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November 21, 1983.

K. ULLAS KARANTH

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11. THE OSPREY (*PANDION HALIAETUS HALIAETUS*) PREYING ON A GULL

In December 1983, I was watching an Osprey circling over Mahim Bay in Bombay. Suddenly the Osprey dived down over a mixed flock of gulls (mainly Blackheaded and Brown-headed) caught one of them in its talons and then flew off in the direction of Mount Mary in Bandra.

I was unable to find any previous record of Osprey preying on another bird in India. Mr Humayun Abdulali, when consulted, could not recollect ever having seen the Osprey feeding on another bird.

Ali-Ripley (1968) state that the food of the Osprey is "Exclusively fish. Often strikes

mahseer (*Barbus*) and others heavier than itself."

Stuart Baker (1928) records that the Osprey's food "is almost entirely fish'.

Witherby *et al.* (1945) state that "when pressed by hunger has been known to take chickens. Also seen to take wounded sandpiper. Jackdaws and wild duck recorded, remains of coot and small duck seen at nest, perhaps wounded birds".

Brown & Amadon (1968) in their book, state that the food of the Osprey is "almost entirely fish, usually taken alive, and up to four pounds in weight ...... Unusual items include some birds, possibly wounded, such as storm petrel, sandpipers and duck, very occasionally land birds like the jackdaw, frogs and crustacea (probably by unskilled young)".

In this case, the Osprey had a clearly defined brown breast-band and was presumably an adult. The gull that was preyed on was part of a flock and there were no indications to suggest that it was injured.

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October 31, 1983.

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12. OBSERVATIONS ON THE ROOF-NESTING HABIT OF THE REDWATTLED LAPWING (*VANELLUS INDICUS*) *IN POONA*, MAHARASHTRA

Notes about the Redwattled Lapwing nesting on roof tops have accumulated over the years (Gole & Mundkur 1980, Tehsin & Lokhandwala 1982, Patnaik 1980). Various reasons have been offered to explain this phenomenon, an interesting one being that the pair are able to gauge the severity of the oncoming monsoons in advance and build on high ground to avoid their eggs and siblings from getting wet.

Apparently, this roof nesting, habit is not a new one (Baker 1935) notes that even though the normal nesting place of this bird is the open ground, it also nests on flat roofed two storeyed houses and the roof of an indigo factory has also been used.

In the last four years a study of at least three pairs (the three were found to be nesting at the same time) of roof-top nesters was done in the Erandavana, Deccan Gymkhana area of Poona. In all five roofs were found to be used, though many similar roofs also existed in the area. It is interesting to note that all the roofs used shared the following characters:

a. All are at least two storey tall buildings.

b. Roofs are flat or very slightly sloped.
c. Roof surfacing being bitumen tar felt sheets with numerous seattered pebbles and stones.
d. Absence of tall briek walls or railings. A seven inch single brick boundary existed on three of the roofs.
e. Presenee of nearby additional ground eover such as water tanks, rock piles, pipe lines, heaped trash that afforded ready protection to the birds were also noted.
f. All the buildings are fairly elose to water (within one and half a kilometres of the river Mutha).

Description of the nest. As all the roofs had pebbles and small cement pieces, these were heaped to form a eircular nest with an outer diameter of about 6.5 inehes, an inner diameter of 5.5 inches and a height of 2.5 inches. These measurements were of one nest only, the others weren't measured as they appeared very similar in size. The moment after the last chiek hatched the nest was abandoned, flattened out and filled up. This behaviour seems very similar to that of the Yellow-wattled Lapwings that nested around two kilometres away on a plateau land.

The following observations are those depieting the fate of each of the nests yearwise.

March 22, 1980. The first nest (nest 1) was discovered on the roof of the Garware College, a three storeyed building with all the characters listed above. Four eggs lay cradled in the nest, their conieal ends pointing to the centre. When the nest was approached the ineubating parent slunk off into some rocks, her back parallel to the ground.

April 6, 1980. The nest was empty and flattened out. After a search four chicks were located and photographed. Their eamouflage was perfeet as were the eggs a few days earlier. One chiek, smaller in size was covered with ants.

May 7, 1980. The chicks were no where to be seen. A new nest had been constructed and it contained four eggs. One egg was much smaller than the others and so I removed it and blew it.

May 29, 1980. Only two ehieks were about, their legs seemed very long and disproportionate. The body was eovered in brown, black and white; a blaek bib was clearly visible on the breast.

During the year 1981, the birds nested between March and June but none of the chicks survived, on nest 1.

In mid April a second pair nested on the roof of another eollege building, a two storey one, lying east to the first (nest 2). The birds eould be seen incubating a numbeı of times but the number of eggs eouldn't be ascertained and their fate is unknown.

The eomplaints of a friend helped me locate another roof with three ehieks (nest 3), as the parents eried every night to the displeasure of the residents in the area. The owner of three stroeyed building found two dead ehicks on the ground the next morning, the fate of the third was perhaps the same. This building lies about 250 metres northwest of the nest 1 roof.

In 1982, nest 1 roof hosted two broods, three eggs in the first and four in the seeond. As mentioned by Bapat (1982) all chicks were found dead, the crows eating some of them.

Roofs 2 and 3 had no nests built that year.

In 1983, nest roof 1 had three nests with four eggs in eaeh. During the third brood, another pair of lapwings nested on another wing of the main building in early August, (nest 4).

August 5, 1983. Two chicks of nest 4 were seen on the roof edge with their parents.

Attacks by crows, often drawn to the roof by our presence quickly brought both parents of both the nests to fight, and they succeeded in chasing the crows off every time. As I didn't expect two nests on the same roof I only found the nest remains after the young had hatched. A fifth nest was found on a three-storey building half a kilometre away but no chicks were seen.

August 6, 1983. Both chicks of nest 4 fell to their death.

August 20, 1983. Nest 1 — Two chicks hatched out and so to prevent this brood also from falling to their death, a friend and I enclosed the nest area with an old wooden frame some six inches tall. The enclosure measured 4 × 6 feet. The parents were seen to incubate even with the frame in place.

August 24, 1983. Four chicks were located in a rock pile outside the frame. How they got over the frame is a mystery!

August 25, 1983. Two out of the four chicks that were found on the ground below were dead, while the other two were replaced on the roof.

August 27, 1983. Both were found on the ground below again, this time one died. The survivor looked very worn out so I took it home as it would have probably been eaten up by a mongoose family that lived close by. A few days earlier I had seen one mongoose eat a fallen bat.

The chick was fed with tepid milk diluted with water from my finger at night and once in the morning, but it died later during the day.

Whether this roof habit could indicate a loss of normal nesting sites has not been adequately answered as a search for ground nesting lapwings proved a failure, even though there are a few spots of broken ground in the area where the birds could have nested.

Finally, it seems a shame that this alternate site should prove so unsuccessful (atleast in the case of the Poona birds). And if this trend continues we would probably see a decrease in this charming bird.

124/9 Erandavana,
Poona 411 004.
Maharashtra,
December 9, 1983.

TAEJ MUNDKUR

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Patnaik, H. P. (1980): Unusual nesting site of Redwattled Lapwing. *Newsletter for Birdwatchers 20*(11): 9.

13. REDWATTLED LAPWING (*VANELLUS INDICUS*) SUFFERING FROM CATARACT

On 25th January, 1983, an adult Redwattled Lapwing (*Vanellus indicus*) was caught and ringed during the Bird ringing/camp organised for members at Nandur-Madhmeshwar. The bird had developed a cataract in the right eye due to which it was blind on the right side. This was confirmed by medical members present. The bird appeared quite active and apparently had no difficulty in flying away when released.

As little is recorded about the disease of birds in the wild state, especially in India, the above observation would be of interest.

27-A/1, CIVIL LINES,
NAGPUR,
July 8, 1983.

NITIN JAMDAR

14. OCCURRENCE OF THE GREAT BLACKHEADED GULL (*LARUS ICHTHYAETUS* PALLAS) IN KUTCH

On February 25, this year (1983) I saw some Great Blackheaded Gulls on Hamirsar lake, just outside the town of Bhuj. There was a group of 25 + of these gulls in company with about 8 or more Caspian Terns — *Hydroprogne caspia* and other waders usually seen on the waterside, along with a flock of Rosy Pelicans (*Pelecanus onocrotalus*) numbering about 100 + which were joined by about another 100 birds towards evening. Owing to the paucity of the monsoon rains in the 1982 season, there was very little water left in this smallish lake; and hence there was a good concentration of fish and other water life.

To the best of my knowledge, *Larus ichthyaetus* has not been previously recorded in this area. As in Saurashtra (Dharmakumarsinhji, BIRDS OF SAURASHTRA), in Kutch also this gull is not at all a common winter visitor.

JUBILEE GROUND,
BHUJ, KUTCH,
November 28, 1983.

HIMMATSINHJI

15. ON THE STATUS OF *PSITTACULA INTERMEDIA* (ROTHSCHILD)

This taxon was first described by Rothschild in 1895, and is known from approximately seven specimens, all collected at about the same time and from an unknown locality, but presumed to be somewhere in the Indian region, since the form closely resembles the parakeets of the *Psitttacula cyanocephala/himalayana/roseata* group. The status of *intermedia* has never been satisfactorily settled, it has been claimed to be either a species, or a hybrid between *P. himalayana* and *P. cyanocephala.* The matter is still unproven, but a

reference, previously apparently overlooked, suggests that there is no concrete evidence for the latter view. The history of the controversy is as follows :

Rothschild originally described the taxon on the basis of a single skin which he said was of the "Bombay preparation" and was therefore likely to have come from the Western Provinces of India. Two skins of *P. himalayana* accompanied the type of *intermedia* and Rothschild believed it to be intermediate between *himalayana* and *cyanocephala* but closer to the former. Subsequently further specimens turned up, and Hartert (1924) in a follow-up note explained that these had come from a "Mr. Dunstall, a dealer in feathers" who had selected six specimens from a much greater number, which he had had in his possession. The fate of these remaining skins is not known, but they probably do not now survive. "Mr. Dunstall" appears to be identifiable as G. K. Dunstall who lived in London at New Zealand Avenue in the Barbican area; few details appear to be available about his life other than that he collected in New Guinea and British Guiana (Guyana) in about 1895 and he supplied skins from these localities and also from New South Wales and New Zealand to the British Museum (Natural History). It seems unlikely that any further details will now come to light as to the precise origin of the skins of *Psittacula intermedia.* Hartert believed that *P. intermedia* would prove to be a local form of which the exact habitat had still to be discovered. He pointed out that if it were a hybrid it would be unlikely that all the known specimens would be found at the same time, and one would expect them to vary somewhat rather than be all alike.

In 1959 two papers appeared almost simultaneously, one by K. Z. Husain putting forward a case for the bird being a hybrid, and the other Biswamoy Biswas claiming that it was a valid species. The latter stresses Hartert's point that if *intermedia* were a hybrid one would expect occasional specimens to appear over a long period of time, not to find a great many at once and then never to find further ones. Unfortunately Biswas's presentation is couched in far less convincing terms than Husain's, which may be why his views have been largely ignored. Husain, on the other hand, argues seemingly convincingly that *intermedia* is a hybrid between *himalayana* and *cyanocephala* but his case rests solely on the undoubted fact that it is exactly intermediate between the two in appearance. He dismisses Hartert's point that the known specimens are all alike, suggesting that first generation hybrids would not necessarily vary in appearance, but ignoring the fact that it would be most unlikely for all the specimens taken from a wild hybrid population to be first generation hybrids. He quotes, but makes no attempt to refute, Hartert's more important point about the unlikelihood of finding so many hybrids all together at the same time. Husain then continues by comparing all the taxa in the *himalayana/cyanocephala/roseata* group, and shows that *intermedia* resembles more closely an intermediate between *himalayana* and *cyanocephala* and is less like either of the other main forms, *finschi* and *roseata.* He concludes : "Thus it can be shown that no other combination of these four species of parakeets than *cyanocephala* and *himalayana* can produce a hybrid like 'intermedia' in nature". But we have little real knowledge of the actual genetics of the four forms, and in any case a hybrid is not necessarily intermediate in appearance between its two parents, and so this statement has little real meaning. Thus Husain's case is really weak, and it is weakened still further

by reference to a note which seems to have escaped his notice, namely that a hybrid between *himalayana* and *cyanocephala is* different in appearance to *intermedia.*

Tavistock (1932-1938) repeatedly paired a male *himalayana* with a female *cyanocephala* and several times obtained young birds. These birds resembled young *cyanocephala* but their central tail feathers were brighter blue with white tips and their heads had a dusky tinge. One of these hybrids was given to a Mr. Whitley and began to show adult plumage with its first complete moult. This description is difficult to reconcile with that of *P. intermedia*, of which I quote below the description by Forshaw, as being the most conveniently worded:

> General plumage green, brighter on rump and more yellowish on underparts; forehead and periophthalmic region rufous pink; remainder of head slaty-purple; chin, broad stripes across lower cheeks, and narrow collar around nape black; ill-defined bluish-green band on neck; maroon patch on wing-coverts; under wing-coverts bluish green; tail-feathers bluish-green tipped with yellow.

The most striking point of dissimilarity is the tail which is yellow-tipped in *intermedia* and white-tipped in Tavistock's hybrids. This difference seems unlikely to be due to the immature plumage of the latter birds.

Thus there would appear to be no hard evidence at all in favour for *intermedia* being a hybrid, and all the available evidence (though admittedly it is not conclusive) points to it being a discrete taxon. Whether it be a species or a subspecies of one of the species in the *himalayana/cyanocephala/roseata* group cannot be determined with any certainty, but I would suggest that it be treated as a species owing to lack of information. In view of the fact that no specimens have been found for so many years, *Psittacula intermedia* is now probably extinct; it was in all likelihood a very small population and may well have been exterminated by the collectors who found it and sent its skins to Dunstall. If it is not extinct, it is very probably highly endangered.

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16. DOWN PLUMAGE IN PARAKEETS, GENUS *PSITTACULA*

(*With a photograph*)

Notes on various aspects of the breeding biology of Indian parakeets are found in Stuart Baker (1927, 1934) and Ali & Ripley (1969). However, these authors and other accounts of field ornithologists consulted by us contain no reference at all to the down plumage of some parakeet chicks, a fact which has recently been pointed out by aviculturists G. A. Smith (1979) and Rosemary Low (1980). In fact, Stuart Baker (loc. cit.) and Dorst (1964) have remarked 'naked young' as a feature of parrots in general. This generalisation is unacceptable even when taken as limited to family Psittacidae (or sub-family Psittacinae) as any experienced aviculturist would readily testify. The following genera of Psittaci, many of which often breed under captive conditions, include species in which the young hatch with a down plumage or assume the down soon thereafter, before their eyes open: *Agapornis* (African Lovebirds), *Poicephalus* (Senegal and Mayer's parrots), *Psittacus erithacus* (African Grey parrot), *Loriculus* (Lorikeets, Hanging or Bat parrots), *Ara* (Macaws), *Aratinga* — (Conures), *Deroptyus* (Hawkheaded parrot), *Bolborhynchus* (Liniolated parakeets), *Pionus* (Sordid parrot), *Graydidascalus* (Short-tailed parrot), *Nestor* (Kea parrot), *Opopsitta* (Fig parrot), *Prosopeia* (Taviuni parakeet), *Psititrichas* (Pesquet's parrot) and *Amazona* (Amazon parrots).

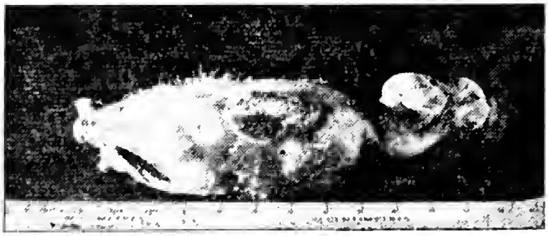

Photo: Redbreasted parakeet chick stuffed specimen, showing hair like down.

2. Recently, a pair of Redbreasted parakeets *Psittacula alexandri* (fallow male × normal female) in the aviary of one of us (Sane) bred, but the young died when about 16 days old. The down plumage of this young (refer to the accompanying photograph) has prompted us to highlight in this note this hitherto largely ignored fact. The following observations relate to this chick:

4.v.82: Egg had started to hatch at about 17.45 hrs.

5.v.82: 09.20 hrs. — already hatched and the chick being fed by the mother; the mother aggressive to permit observations on the chick.

6.v.82: Long but sparse hair-like down on the lower back clearly visible; head naked.

12.v.82: Eye membrane slit clearly seen but eyes not open; no trace of feather pins but fluffy feathers of the secondary down slightly seen, especially on the back.

13.v.82: Eyes not open, but the body skin darker than before; secondary down clearly visible in the lower back, but it is not as soft and dense as the down of Rosellas, Conures and Lovebirds; primary down also clearly seen.

15.v.82: Eyes open in the evening and the general body colour still darker.

17.v.82: Flight feather pins have started to appear; secondary down more prominent and is also seen on the abdomen and flanks bordering the rudimentary wings.

20.v.82: In the morning, the young found in good condition but at about 18.00 hrs it was dead and the body still warm. Death probably due to over-feeding of the young by the mother on an extremely hot and humid day.

These observations, are similar to down plumage described for *Psittacula derbyana* and *P. longicauda* respectively by Smith and Low in that a long thin hair-like primary down is followed by a dense woolly secondary down. Describing the down of *derbyana*, Smith (loc. cit.) states 'Two chicks, when observed at approximately 14 days old were covered in a thick woolly bluish-grey down'. This is confirmed by Low's (loc. cit.) statement 'Newly hatched young have some white down. The second down is grey dense giving a woolly appearance'. In the case of *longicauda* Smith reports 'Rather surprisingly, the chicks have white thin long down and are not 'stubby-naked' as are most other Psittacula parakeets'.

It is interesting that the three species of *Psittacula* in which a well marked down plumage has been noted (*derbyana, longicauda* and *alexandri*) resemble each other in possessing a prominent black moustachial patch and conspicuous black forehead extending to the eyes in the form of a black band. *P. caniceps*, which resembles these three species, has not been studied at all and the bird has hardly ever been kept in captivity by aviculturists, but it is possible that this species also possesses a down plumage. All these four species also possess a more massive head with a somewhat flat top as opposed to the more rounded and relatively small heads of *cyanocephala, roseata* and *calthropae* which are known to have naked young, a fact confirmed by first-hand observations on captive born birds by one of us (Sane).

P. eupatria and *P. krameri* which resemble each other in coloration to a remarkable extent, appear to be in-between these two groups of *Psittacula*. In *krameri*, having a rounded and relatively smaller head, the chick is naked without even a trace of down. According to Smith, in *eupatria* (which has a large flat-topped head) the chick is "...... covered with fine and unobstrusive, extremely short, one mm. long or so thinly scattered natal down which abrades off to leave them naked after a day or two." The black chin patch of these two species begins at the base of the lower bill and is not comparable to the moustachial patches of *alexandri, derbyana* and *caniceps* which start from the sides of the lower beak.

Smith refers to the difference between the observations in respect of down plumage of *P. himalayana* by Alston (1967) and Baele (1977). According to the former, in *himalayana* the young was naked, but the latter reported 'thin down' in a chick of a partially yellow mutant crossed with a normal specimen of the same species.

It is not our intention to correlate the presence or absence of down plumage in *Psittacula* chicks only with the head shape of these birds or any other character. Our aim in writing this note is to draw attention of ornithologists to the presence of down plumage in some parrots including a few Indian *Psittacula* and to suggest that species showing this character appear to have certain other common bodily features indicating a closer taxonomic affinity between them than others of this genus.

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17. ON THE JUVENILE PLUMAGE OF FEMALE *CHRYSOCOLAPTES FESTIVUS* (BODDAERT) AND OTHER NESTING NOTES NEAR BOMBAY

(*With a plate*)

This morning (24 Feb., 1983) I visited the Borivli National Park, Salsette, Bombay with Shri G. S. Kandey, Divisional Manager of the park, with a view to putting up some nest boxes on trees along the roadside. Starting at the southern end of the park we put up some seven boxes when we reached the several old palmyra palms riddled with holes (Plate) which we had over several years seen visited by the Spotted and Jungle Owlets (*Athene brama* and *Glaucidium radiatum*), Roseringed Parakeets (*Pstittacula krameri*), Blackbacked Woodpeckers (*Chrysocolaptes festivus*) and Mynas (*Acridotheres tristis*). Though the young of several species had been seen looking out and other behaviour left no doubt regarding their nesting in these holes, we never had had the opportunity of actually examining the contents.

Today we were accompanied by a climber and we sent him up to examine two holes in two separate palms. The first yielded a young woodpecker, about three-fourth fledged. The feathers on the head were yellow shot with red and I have earlier (*JBNHS* 72, pp. 129-30) referred to two females with shorter bills (presumably young) and the yellow of the crest showing traces of red. Together with an old note of a redheaded bird being fed by an adult male, it would appear that young females have a yellow head shot with red, while young males have completely red heads. Stuart Baker, 1927, (*Fauna* 4, p. 77) states that young females "if we can judge from the young of the closely allied *C. striatus* have the head black spotted with white". This is an erroneous presumption accepted in INDIAN HANDBOOK (4, p. 241).

The second nest contained three young parakeets and one well-fledged bird pulled out was on the point of being put back as of the Roseringed, when several of us noticed its large size and binoculars revealed the red patches on the shoulders, indicating that it was the large Indian or Alexandrine Parakeet (*P. eupatria*). Almost 50 years ago Salim Ali and I (*JBNHS* 40, p. 167) had referred to this bird as occasionally seen in Bombay City, but not in the forest areas and treated it as an escape. In more recent years pairs and small parties were occasionally seen at the

The nesting palms.
(*Photos* : S. R. Nayak)

entrance to the Film City, but this appears to be the first record of a nest being actually found. There was considerable difference in size between the three young parakeets, one other being almost featherless.

Both young were extraordinarily pretty birds. The palmyra palms referred to above are no doubt dying out (one is already headless) and it would appear that in many instances, the bottom of a hole has dropped through the top of the one below and rendered both uninhabitable. I remember a time when you could knock at the bottom of a palm and have a young or adult put out its head to inquire, while further knocking produced another head from a 'flat' higher up.

Dead wood is getting scarcer and scarcer and it is hoped that some of the birds will use the nests offered and continue to be able to find their food within the park.

I thank Shri Kandey, for his assistance.

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18. ON THE COLLECTION OF HAIR FROM THE TAIL OF LIVE CATTLE (COW) BY THE JUNGLE CROW (*CORVUS MACRORHYNCHOS*) FOR NEST-BUILDING

During the last two years (1981-82) I have been observing Jungle crows (*Corvus macrorhynchos*) extracting the long hairs from the end of the tail of cattle (cows) during the birds' breeding season. On a morning (11.45 a.m.) of March 1983, I happened to look through the office window and saw a single Jungle crow alighting in between the two horns of a cow lying in the portico of the Zoology Department of Calicut University. The bird started picking up insects or fleas and slowly climbed down to the back of the animal and then gradually to the anal portion till it could reach the hairy end of the tail. This process appeared to me as something comparable to that of a man calming down an unfriendly cow before milking.

Later, the crow started forcefully 'pulling' and extracting the hairs. The extracted hairs were evenly placed crosswise in the beak and then the bird flew away. The entire collection process lasted about 7 minutes and the cow at times appeared to be disturbed probably due to pulling of the hairs, but she did not get up to move away. Thanks to the hundreds of village cattle living in the campus, the Jungle crows could collect enough hairs from the tail of live cattle to line their nests. Though I did not actually see the bird placing the hairs in any nearby nest, it was apparent that the crow was engaged in the process of building one somewhere in the campus.

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19. FEEDING TERRITORIES OF THE SMALL SUNBIRD (*NECTARINIA MINIMA* SYKES)

(*With a text-figure*)

During the non-breeding season nectar feeding birds often defend territories with flowering plants against other nectar feeding birds (Stiles 1975, Gill and Wolf 1975). Thus certain individual birds have continual access to a nectar source. Acquiring non-breeding territories might help the individual gain better breeding territories and thereby increase its fitness. These territories appear to be resource based (Gill and Wolf 1975). The dynamics of territoriality in the small sunbirds (*Nectarinia minima* Sykes), a nectar feeding species occurring in the Western Ghats, were observed in the Nilgiris, southern India from May until September 1976 and 1977. The relationship between defence and the quantity of food in the territory was estimated.

The methods employed in answering this question were : 1) selecting a suitable study site with many individual flowering plants; 2) tagging all the flowering individuals on the site, and monitoring flower production during the study period by counting all flowers on the plants at regular intervals (approximately once a week); 3) and observing individual plants to note visitation patterns and territorial defence by marked and recognisable birds. Birds were either colour banded, or could be easily recognisable by their distinctive moulting patterns (Davidar, *in press*).

The study site chosen was Wellington shola which has an area of about one hectare. The flowering plants in this site were *Helixanthera intermedia* Wt. (Danser), *Dendrophthoe falcata* (Linn. f.) Etting, *D. memecylifolia* (Wt. & Arn.) Danser. *D. neelgherrensis* (Wt. & Arn.) van Tieghem, and *Taxillus cuneatus* Roth (Danser) — all of the hemiparasitic mistletoe family Loranthaceae. *Helixanthera intermedia, D. memecylifolia* and *Taxillus cuneatus* were visited by small sunbirds for nectar and flowered from May to September (Davidar 1983, *ms.*). Only male small sunbirds defended territories, and advertisement appeared to be more important in territorial defence than direct aggression (Davidar *ms.*). Territories were defended intra- and inter-specifically between small sunbirds and flowerpeckers.

Territorial zones were marked in Wellington shola from May to September 1976 and 1977. The zones were based on observations on individual sunbirds and flowerpeckers (Fig. 1). Area A contained 9 plants of *H. intermedia,* and 2 plants of *D. memecylifolia.* Area B had one plant of *H. intermedia,* 2 plants of *T. cuneatus,* 4 plants of *D. memecylifolia,* one plant of *D. falcata* and one plant of *D. neelgherrensis.* Area C and 2 plants of *D. memecylifolia,* and area D had 7 plants of *H. intermedia.*

In May 1976 one adult male small sunbird established a territory in B and C, and another male in A. A juvenile male small sunbird visited territory A when the territorial bird was not there (Fig. 1). This continued in June and D was visited by an assortment of birds. In July flowering intensity decreased, both males visiting A left, the male in B and C was still there, and a female visited the other undefended flowers in the study site. In August the bird in B and C left, the female sunbird was still around, and a flowerpecker

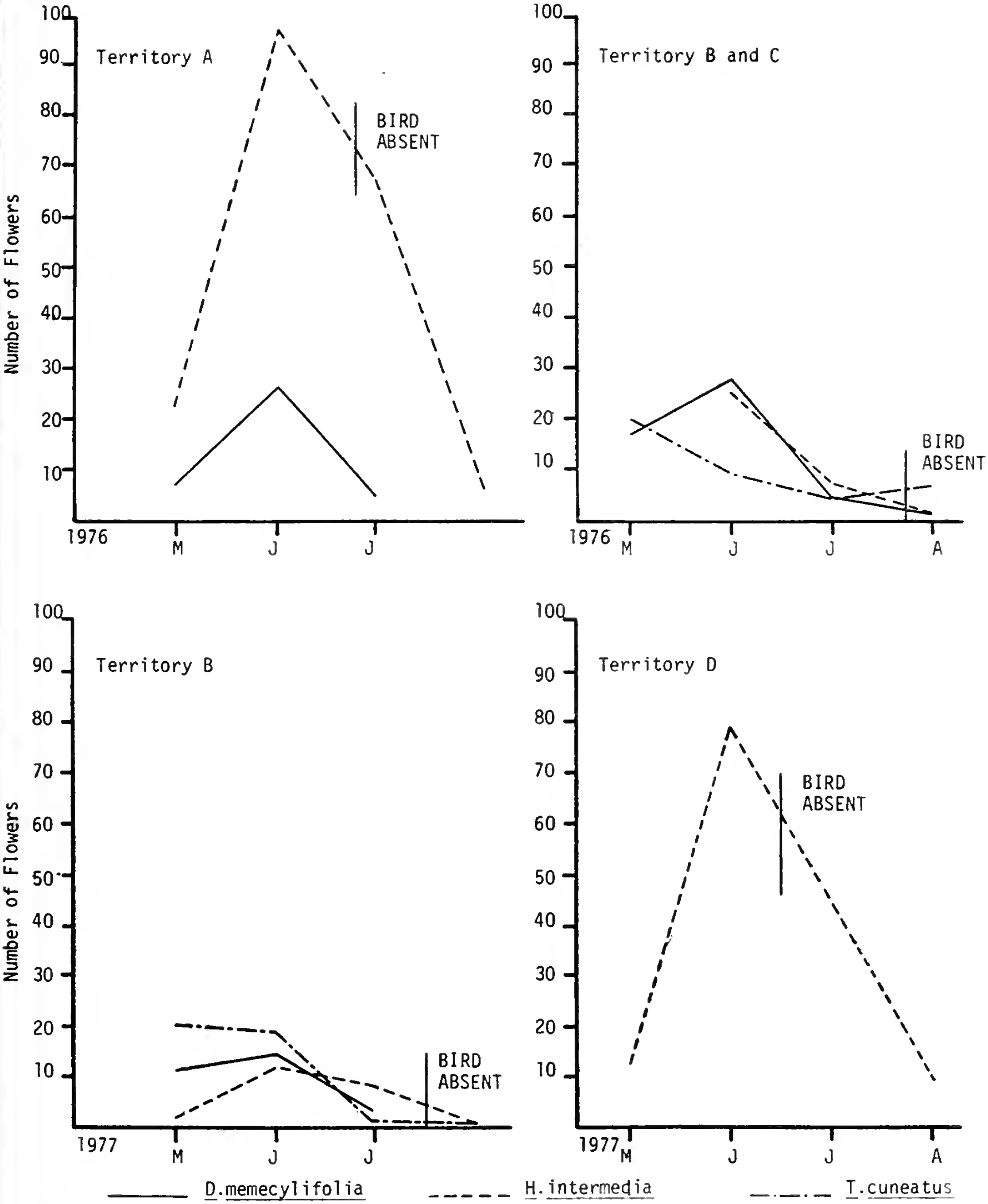
Territory A
BIRD
ABSENT
Number of Flowers
1976
M
J
J
Territory B and C
BIRD
ABSENT
1976
M
J
J
A
Territory B
BIRD
ABSENT
1977
M
J
J
Territory D
BIRD
ABSENT
1977
M
J
J
A
D.memecylifolia
H.intermedia
T.cuneatus

Fig. 1.

which had visited the *T. cuneatus* plants earlier on, was joined by another. In May 1977 (Fig. 1) area A was defended and visited just as in the previous year — there was an adult territorial male, and a juvenile intruder male. Another male defended B. C and D were not visited at all. In June the male visiting A visited D. In July D had no visitors except for one flowerpecker which foraged over the entire area.

The territories seemed to be formed before the flowering peaks (Fig. 1). It seems as if birds return to a specific site the early wet season, and then defend the flowers that blossom later. Two marked small sunbirds returned to the same site on consecutive years, one of which (Z-10072) returned for three consecutive years. It also appears that *H. intermedia* is defended for a longer period in mixed rather than in single species stands because the quantity of nectar produced is lower than in other species. There appears to be a definite relationship between defence of areas and the quantity of food on the territory (Fig. 1) toward the peak and the tailend of the flowering season, however initially the territories appeared to be established based on prospective value of resources, rather than their actual value. This has not been documented for other nectar feeding birds (ref. Gill and Wolf 1975).

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20. BLACKBREASTED WEAVER BIRD (*PLOCEUS BENGHALENSIS*) OBSERVED IN HYDERABAD

On 5th June, 1983, we had been on a birdwatching trip to a place about 15 km on the outskirts of Hyderabad City (17°20′ N; 78° 30′ E) along the banks of River Musi. There was very little water in the river but a luxurious growth of water hyacinths and reeds was seen. A few boulders in the almost stagnant water, some spots of small marshy areas and a couple of mounds with algae growth could be seen. There was bushy vegetation along the slopes with a few trees on the banks. Undulating fields, some under cultivation (paddy and fodder grass) and others still unploughed. A dry nullah leading to the river with bushes growing in it and a poultry farm near by made up the surrounding habitat. There was a fairly large palm grove near by. Most of the trees and bushes

were *babool* with a few wild castor plants. Cactus was growing as field dividers. Our observations were made between 1300 hours and 1700 hours. Here we observed for the first time the Blackbreasted Weaver Bird (*Ploceus benghalensis*) in the wild. There were about 100-150 birds in small flocks along with the Baya (*Ploceus philippinus*) and a few Streaked Weaver (*Ploceus manyar*), the total number of birds being about 250-300. Since all the 3 species of birds were seen together, identification of the Blackbreasted Weaver was not difficult. Most of the birds seen were in full breeding plumage. The male *P. benghalensis* had a bright yellow/golden crown with the nape and side of the neck brownish black. The throat was dirty white, as also the under belly. A dark brownish black band across the breast up to the side of the 'shoulders', speckled at the edges but distinctly separating the dirty white throat from the under belly. Wings and upperpart of the tail was brown, streaked with black and the beak ashy grey. The female had dark brown speckled band across the breast but less prominent than in the male. Head and ear-coverts, brownish with a little yellow on the side of the neck. Under belly was dirty-white.

The birds were seen in flocks of 50-60 each with several such flocks totalling nearly 250-300 birds. These birds were in mixed flocks of Bayas, streaked weavers and Blackbreasted weavers. About half the flock must have been *Ploceus benghalensis* the other half being *P. philippinus* as this was the ratio of each species seen amongst the flocks observed. Not more than 30-40 *P. manyar* were seen though they could have been more. Of the birds seen (all 3 species) there were more males than females. Every 20-30 minutes a flock would suddenly take off from the fields or from the top of the trees or bushes and 2 or 3 flocks would zip around criss-crossing once or twice before alighting again in a field or settling down on a tree. Some birds would come in twos and threes and sit on the electric wires. A few birds were seen taking a water bath in the paddy fields which had a little standing water. The movement of the flocks was more frequent around 1430 hours than at 1600 hours and by about 1700 hours most of the activity had seized even though a few birds could still be seen. Except for a few nests of the Baya on some babool trees, no nesting or nesting activity of either of the Streaked Weaver or the Blackbreasted Weaver was observed. Still being in full breeding plumage and at a time when it is their breeding season (March-September), the Blackbreasted Weavers could very well be breeding or preparing to nest as the habitat and other conditions were quite suitable for it. According to the HANDBOOK (Ali & Ripley, Vol. 10, 1974) *Ploceus benghalensis* is "an endemic species. Resident, subject to local movements; common but locally and capriciously distributed" and its distribution given as "Pakistan, northern India, Sind, Gujarat, Punjab, the Gangetic plains, Bangladesh, Assam, Manipur and Bhandup (Bombay). There is only one record from South-west Madhya Pradesh. Breeds in the duns of U.P." Further they state : "the southernmost point of distribution of the Blackbreasted Weaver is Bhandup (Bombay) and Bastar (M.P.), both places between 18°-20° N; and breeding in the duns of U.P. and in north and north-east India up to 1200 m."

Note. The local pet bird trappers report netting of *Ploceus benghalensis* from the region around Hyderabad City environs, especially near the place where we sighted these birds. In 1982 (about the 3rd week of July,

we have seen the *Ploceus benghalensis* in the local pet shops which are reportedly being trapped for the past 3-4 years only and were not found amongst the Bayas netted in the earlier years (prior to 1978-79).

The following interesting questions arise from our observations of *P. benghalensis* in the environs of Hyderabad.

1. Since a fairly large number of *P. benghalensis* were seen (about 100-150) in a relatively small area of about 1 sq. km, and in full breeding plumage, they could be nesting somewhere further down the river where there could be more such flocks.
2. Could the birds seen be 'escapes' which have established themselves and started breeding? What is their status since the species has been known to occur in this region only for the past 3-4 years regularly?
3. When such sizeable numbers are being observed in the wild in this region for so many years, could it be that the range of the *P. benghalensis* has extended which till now had not been noted. If so can it be accepted?
4. Are there reports of similar observations from other regions, especially from around northern Andhra Pradesh, north-eastern or eastern Maharashtra or Southern Madhya Pradesh?

P.S. The Blackbreasted Weaver birds were again observed on 7th June, 1983 at the same place mentioned above by one of the authors (Aasheesh Pittie) and another person.

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21. BLACKHEADED MUNIA, *LONCHURA MALACCA MALACCA* IN JASDAN, GUJARAT

On the 23-x-83 I saw a flock of 8 Blackheaded Munias in a river bed with water and some reeds and grass about 6 miles from Jasdan below the Shivsagar Tank. The birds were flying about strongly and were in excellent plumage.

I have not previously seen this bird in Gujarat and it would be interesting to know of other records in Gujarat and the adjoining areas of Maharashtra.

SHIVRAJKUMAR KHACHAR
JASDAN,
GUJARAT 360 050,
November 2, 1983.

[Gujarat does not fall within the distributional range of the three races of the species inhabiting the Indian subcontinent. The nominate race occurs in Sri Lanka and Southwest India and south of Belgaum in the Peninsula, the other two races *rubroniger* and *atricapilla* are restricted to Nepal, Uttar Pradesh, part of the Punjab, and Bihar. The nominate race has been reported from time to time from further north in the Peninsula — Pachmari, Hoshangabad district, Warrangal and Godavari districts, and Ratnagiri. Br. A. Navarro, S.J. took eggs of the bird at Khandala on 28-x-1938, and Mr Humayun Abdulali collected a specimen of the nominate form on 26-i-1954 in the Thane district of Maharashtra. The latter had clipped wings and was certainly a cage escape. The Blackheaded Munia is a much sought after cage bird and the flock reported by Mr Shivrajkumar Khachar could be of such escapees or their progeny. — Eds.]

22. COMMENTS ON "SOME INTERESTING ASPECTS OF THE AVIFAUNA OF THE POINT CALIMERE SANCTUARY, THANJAVUR DIST., TAMIL NADU BY R. SUGATHAN (JBNHS 79, pp. 567-75, 1983)"

Eight species are listed as being the first records for this area and are placed in separate sections. Almost every one of them calls for some remarks.

(a) *Phoeniconaias minor* : The first two paragraphs deal with the Large Flamingo and as one begins to wonder if there is an error in the title, reference is made to the first record of the Small Flamingo in July 1980. A footnote tells us that it was first reported by R. A. S. Melluish in February 1968 in Newsletter for Birdwatchers (edited by Zafar Futehally then Hon. Secretary of B.N.H.S.). Some information regarding the different foods of the two species is already available and though we are told that "the feeding ecology needs to be studied", no effort yet appears to have been made. There is at least no indication of the kind of work done.

(b) Nominate *Aviceda leuphotes* (127) was described from Pondicherry and another race *syama* from the N. E. Himalayas. The form reported as a migrant into Ceylon is suspected to be of this race. In my Catalogue (*JBNHS* 65: 697) I have indicated my inability to separate the 6 specimens in the Bombay collection into these two forms, but the single bird netted at Pt. Calimere has prompted the suggestion that it was of the nominate race and on its way to Sri Lanka.

(c) An *Otus scops* (617) was obtained and it is suggested that it was of the race *leggei* from Ceylon. The specimen is available and is very close to a *rufipennis* (type, Eastern Ghats) from Vizagapatnam, *Leggei* is suggested because of a short tarsus (19 mm.) ignoring the fact that the 140 mm. wing makes it too large for *leggei* (IH 118-127). Why was it compared with specimens of *sunia* and not *rufipennis* of which we have a topotype collected in March 1981.

(d) Two species of Green Pigeons (both of which are represented by insular races in the low country in Sri Lanka) are recorded and without reasons for accepting them as of the Ceylonese race(s) it is said "it will be interesting to know whether there is any local migration between the peninsula and Sri Lanka".

(e) Indian Cliff Swallow (922). The capture of a single specimen is quoted as "in a way, corroborative of an earlier sight record from Sri Lanka".

(f) *Erithacus brunneus*: In a contribution

to the collection of essays on Hora's Satpura Hypothesis, it was suggested that the Eastern Ghats were a possible route of migration alternative to the Satpura and the Western Ghats, for the Indo-Malayan Fauna from the north-east to the south-west[1]. The numerical evidence in favour of the Western Ghats was then greater, possibly due to the area being better known. The evidence in favour of the Eastern Ghats is being added to in recent years and it is strange that the occurrence of *Erithacus brunneus* at Pt. Calimere should be brought forward as further evidence of the passage down the Western Ghats.

(g) *Carpodacus erythrinus*: One was obtained at Pt. Calimere and this is not very far from the southernmost record in India. It is again mentioned that it has not been found in Sri Lanka hinting (?) that it was on its way thereto.

(2) The term Checklist heading the list of species in the second half of the paper implies that all previous records have been included. Several however, i.e. Whitethroated Ground Thrush, *Phylloscopus affinis*, Wigeon and *Accipiter gularis gularis* are omitted, and the list is nowhere near complete.

(3) The list adds very appreciably to the last list and a closer examination of these records may have raised points of interest. The dates indicating autumn and spring migration are not (clearly) stated, several of the mass migrants presumably going into Ceylon showing a one-way movement. This can be due either to a different return route or netting on the wrong dates in spring. A clarification of this point would be of great interest.

(4) Several of the birds listed are almost certainly wrongly identified, e.g. *Turdoides striatus*. *Mirafra erythropterus*, *Galerida cristata*, and *Caprimulgus europaeus*. In commenting on a recent record of *Sterna veredes* from off Madras, Sálim Ali has very rightly stressed the need of a specimen to substantiate records of a rare or extraordinary value. If there are wrong identifications in any of the reports of the present projects, they will be very difficult to eliminate for they have presumably been vetted by Dr Sálim Ali.

(5) The report would have been more useful if accompanied by a sketch showing the geographical situation of the area concerned, particularly with relation to the Eastern and Western Ghats.

75 ABDUL REHMAN STREET,
BOMBAY 400 003,
February 27, 1985.

HUMAYUN ABDULALI

Comments on Mr Abdulali's note on Dr. Sugathan's paper on Avifauna of Point Calimere

1. *First records*: All the species recorded in the said paper were carefully examined *in hand* with the help of standard reference books before being ringed and released (or preserved as specimen, when found necessary to do so. Specific instructions were followed by the field staff in recording field data).

(a) *Flamingos*: Earlier reference to Lesser Flamingos were only *sight* records. The paper is based on the specimen actually examined in hand and ringed as the case may be. Feeding ecology of both species of Flamingos in Chilka, Point Calimere, Rameshwaram and Sri Lanka have not been studied according to our knowledge. The project staff

[1] Proceedings of National Institute of Sciences of India, Vol. XV, No. 8, 1968.

have made attempts to study this but this aspect does not come under the purview of this paper. When sufficient data is collected, the results will be offered for publication in the Society's journal in due course.

(b) *Baza* : It is a common knowledge that separating subspecies in the museum specimens is difficult, leading sometimes to erroneous assumptions. The Point Calimere identification was based on a living bird examined in hand, therefore there was no doubt about its subspecific identity as mentioned in the paper.

(c) *Scops Owl* : The Point Calimere specimen is definitely *darkest* of the only three *rufipennis* available in the BNHS collection including the topotype from Eastern Ghats. The reference in the paper should have read *rufipennis* not *sunia*. The error is regretted. (There are more than three *sunia* in the collection). Tarsus is definitely smaller than that of both *sunia* and *rufipennis* though the wing is 140. Attention is drawn to the fact that the identity of the bird is followed by a query, which is an accepted norm whenever there is doubt about the identity.

(d) *Green Pigeons*: HANDBOOK specifically states that *pompadora affinis* occurs in the hill regions of S. W. India. Its occurrence in Point Calimere is noteworthy, while *bicincta* is said to be subject to local migration in Sri Lanka.

(f) *Blue Chat*: If one carefully reads the paper it is apparent that what is implied is that the birds *may be* taking different routes (either Eastern or Western Ghats) in their autumn and spring migration.

2. Omissions are regretted.

3. Attention is drawn to the ringing totals tabulated in the project reports I & II which show the possible trend of the autumn and spring migration through Point Calimere.

4. The species were identified after examining in hand. *Turdoides* from Point Calimere is assumed to belong to *striatus* species since not a single bird caught and ringed in the field (over 400 individuals) had any trace of white on head. In this particular case, ironically, Mr Abdulali appears to have based his judgement on a single specimen purported to have been collected from Point Calimere. The label bears Dr Gaston's name and to the best of our knowledge, the only time he visited Point Calimere, Dr. Gaston did not collect any specimen from the area. However, detailed study may reveal the status of *Turdoides* population in Point Calimere. As for the other identifications, the species mentioned by Mr. Abdulali are not so rare and their occurrence in peninsular India, though not recorded from Point Calimere, is an accepted fact. The field identification is based on live birds, examined in land with the help of standard literature, and there is no reason not to accept their occurrence from Point Calimere, especially when there have been earlier *confirmed* records and some of the species of evergreen biotopes of Western Ghats (*Schoenicola platyura, Ceyx erithacus erithacus, Mirafra erythroptera erythroptera, Zoothera wardii* and *Zoothera citrina citrina*). I would, with due respect, ask Mr Abdulali to physically examine the birds concerned before commenting on the identification. A visit by him to Point Calimere would perhaps remove some of the misconceptions.

Attention is drawn to a specimen of *Accipiter* recently collected by the field staff at Point Calimere. This specimen was caught alive but was preserved since the field staff thought its identity rather intriguing. Later in the Society's bird room I drew Mr Abdulali's attention to this as well as earlier *Accipiter* specimens brought from Point Calimere and added to the collection. It was pointed out to

Mr Abdulali that the latest specimen from Point Calimere as well as earlier one collected from Bharatpur calls for re-examination and revision of a recently published paper on *Accipiter* by Prof. Mees (see *JBNHS* 77: 371-412) which also includes a newly described subspecies (incidentally this subspecies was described based on a single male specimen!) Mr Abdulali has informed me since then that the Bharatpur specimen has been identified by Prof. Mees himself as *A. v. affinis* a Himalayan subspecies, believed to be winter migrant to Burma and Indo-China. Prof. Mees, I understand, has made necessary corrections in a subsequent paper submitted for publication in the *Journal*.

This episode is mentioned here to illustrate the point that the field staff follow the instructions and are careful in either identifying the birds or when a particular bird is intriguing or beyond their capacity to identify, preserve it and send it to Bombay for further study/verification.

S. A. HUSSAIN
Project Scientist
Avifauna Project

23. ON THE INFANTILE MORTALITY OF OLIVE RIDLEY, *LEPIDOCHELYS OLIVACEA* (ESCHCHOLTZ) IN CAPTIVITY

The Pacific (Olive) Ridley, *Lepidochelys olivacea* (Eschcholtz) is an endangered species. So, attempts are being made to rear and rehabilitate this species at Bhagabatpur Crocodile Rearing Centre, Sunderbans, West Bengal.

In the course of rearing, 117 Ridley hatchlings emerged from their artificial nests at Bhagabatpur within a hatching span of 6 days with effect from May 17 to May 22, 1983. Of these, 99 healthy hatchlings were released and 18 were segregated for study (Banerjee 1984). Of the 18 hatchlings 3 had certain developmental abnormalities, namely 2 had unusually bent carapace and one had no eyes. But, within a month, *i.e.* by June 17, 1983, the abnormal Ridleys along with 2 other weak hatchlings died.

On June 19, 1983, there was an outbreak of skin infection among juvenile Ridleys similar to that reported by Whitaker (1982). It was treated successfully with Terramycin Antigerm-77 solution by July 7, 1983 without any mortality (Banerjee 1984). But, since then, one hatchling went off its food and consequently showed stunted growth. It completely stopped feeding and died on August 16, 1983.

One healthy hatchling was found dead on July 13, 1983. Post-mortem report revealed internal haemorrhage and injury to heart. It happened due to an accident during pool cleaning and was not unfortunately brought to our notice.

One hatchling with bifurcated fore flipper also showed retarded growth in comparison to others. This juvenile turtle stopped feeding a week after the disappearance of the second attack of skin infection and died on April 12, 1984. The post-mortem report revealed enlargement of liver.

To date, i.e. over a period of one year, the total infantile mortality rose to 8 (44.4%) and 10 yearlings are surviving.

BHAGABATPUR CROCODILE PROJECT,
BHAGABATPUR, 24-PARGANAS, WEST BENGAL,

R. BANERJEE

1. Male blood sucker holding female; 2. Male and female in the copulatory position; 3. Male in agony, hanging by right forelimb. See its tail and hindlimbs; 4. Blood drops coming out from cloaca.
(*Photos* : Author)

ZOOLOGICAL SURVEY OF INDIA, N. C. NANDI
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DEPARTMENT OF ZOOLOGY, S. K. RAUT
CALCUTTA UNIVERSITY,
KERALA,
July 9, 1984.

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24. FRESHWATER TURTLES CAPTURING COOTS

On the morning of 8th Ocober 1984, I observed a scuffle between a freshwater turtle and a coot in one of the open water areas of Bharatpur's Keoladeo National Park. The turtle had a firm hold of one of the coot's feet, and the bird tried to escape by flapping about noisily, dragging the reptile along. The struggle lasted for more than 5 minutes during which the bird kept floundering and splashing about the water surface, while the turtle remained almost submerged most of the time with only its head and carapace showing up now and then. Finally the exhausted bird managed to 'shake-off' the turtle's strong hold by squeezing through a clump of grass.

My enquiries with the sanctuary personnel and also with the other BNHS staff reveal that such incidences of turtles harassing coots are not uncommon. Some say that the turtles at times amputate the birds' feet, leaving it handicapped and helpless in the marshes. But none of them have seen the turtle actually feeding on the bird.

JUNIOR FIELD BIOLOGIST, R. KANNAN
BNHS ECOLOGICAL RESEARCH STATION,
BHARATPUR 321 001, RAJASTHAN,
October 29, 1984.

25. MATING BEHAVIOUR IN GARDEN LIZARD OR BLOOD SUCKER, *CALOTES VERSICOLOR* DAUDIN

(*With a plate*)

We have been observing the garden lizard (*Calotes versicolor*) for quite some time in the hedgerows surrounding our house. On the fourth of June, we saw a male lizard in brilliant breeding coloration head, shoulders and forelegs crimson, and black patches on the sides of the throat and cheeks bulging. At the sight of a female lizard, the male ran after

and chased it until he got a grip on the female's neck with his jaws and he immediately took the position of mounting (see plate 1, 1). Then the male lizard twisted his tail and tried to copulate with the female (plate 1, 2). The female escaped from the copulatory embrace and jumped to a nearby twig. At this moment the male lizard shrank back and hung on to the tree by the claws of the right forelimb only, The digits of both the hindlimbs were bent inwards (Plate 1, 3). Suddenly, we saw 3 to 4 drops of blood falling down. After about two to three minutes, the male became normal and was on all four limbs. Then we realized that those blood drops were coming out of the cloacal region (Plate 1, 4).

We are of the opinion that whilst the female was escaping, one of the claws of her hindlimb must have scratched the hemipenes of the male lizard resulting in injury. It is also possible that the sudden tearing away by the female during copulation could have caused the bleeding injury in the male.

A few days after the above incident, we often saw the same male in the hedgerow but with a noticeable swelling under the base of the tail.

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Bhavnagar Para,
Bhavnagar 364 003.
June 7, 1984.

RAJU VYAS
NITIN VYAS

26. NEST GUARDING BY ESTUARINE CROCODILE — A BEHAVIOUR STUDY IN THE SUNDERBANS

While the aggressive behaviour of crocodilians at nest is widely acknowledged and has been commented upon by several authors (Bustard and Singh 1981, Whitaker 1982, Deraniyagala 1939), Biswas (1982) stated that "Guarding the nest .... is not necessary or always associated with the breeding behaviour of the estuarine crocodile". This however is not adequately documented.

It may be useful to place on record a few observed instances of response to egg predation, and behaviour near a nest among free living estuarine crocodiles.

During collection of *Crocodylus porosus* eggs in the Sunderban for artificial hatching at Bhagabatpur crocodile project of the Forest Department, Government of West Bengal, one nest mound was detected on 4-vi-83. A wallow observed near by had crocodile pawmarks in it. The hind paw measured 24 cm. No crocodile could however be seen. On 7-vi-83 at 6 a.m., the same nest was approached. A 3 metres long crocodile was seen lying under a dense low bush, approximately 18 metres away. It was totally indifferent to our presence. The air temperature recorded was 31.5°C. 45 eggs were collected from the nest, which took approximately 10 minutes. The crocodile was never disturbed.

On 5-vi-84 one crocodile was observed floating near the mouth of a narrow creek about one kilometre away from the previous year's nest. It dived at an approach distance of 15 metres by boat. Crocodile pawmarks found near the spot were followed through the creek 2 minutes later in knee deep silt and mud. The hind paw measured 18.5 cm. 100 metres away the spoors were lost in thick mangrove

vegetation comprising mostly of *Phoenix paludosa.* Careful investigation led to a crocodile nest approximately 10 metres away from the bank. A wallow near by had no discernible mark of use by a crocodile. No crocodile was encountered on the way back. The nest was again approached on 6-vi-84 and 51 eggs were collected from the nest. The crocodile was not in the area.

R. BANERJEE

BHAGABATPUR CROCODILE PROJECT,
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WEST BENGAL,
July 2, 1984.

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27. RESULTS OF 1981 SURVEY FOR GHARIAL (*GAVIALIS GANGETICUS*) IN NORTH NATIONAL CHAMBAL SANCTUARY

(*With a text-figure*)

INTRODUCTION

Chambal river from Kota to Pachnada a total of 560 km was declared as National Chambal Gharial Sanctuary in 1978-79. This is a tristate Sanctuary under the forest departments of Madhya Pradesh, Uttar Pradesh, and Rajasthan. The Gharial which was on the verge of extinction (F.A.O. 1974) was conserved under a grow and release programme. In this programme Uttar Pradesh initiated a large scale rearing work and collected a number of eggs and at a size above 5 feet during 1979-1981, a total of 272 Gharials were released in the present study area (Bhavesuri-Gyanpura) and 166 upstream of the area (Table 1). I had participated during the releasing programme of Gharials by U.P. forest department in the study area described in this paper.

From 1981 Madhya Pradesh also started collection of eggs and is operating a Gharial Rearing Project, but they have not released any Gharial so far. The present paper gives an account of Gharial population in a limited area of Chambal river on the northern region of the Sanctuary during 1981.

STUDY AREA

The present study area of 138 km of Chambal river (26°45′ N, 78°45′ E) was surveyed on both the banks from Bhavesuri to Gyanpura during October 1981 over 7 days. 7 different stretches were described (see Table 2) to carry out the observations. This area consists of sandy banks and rocky hills. The Gharials usually bask on these sandbanks.

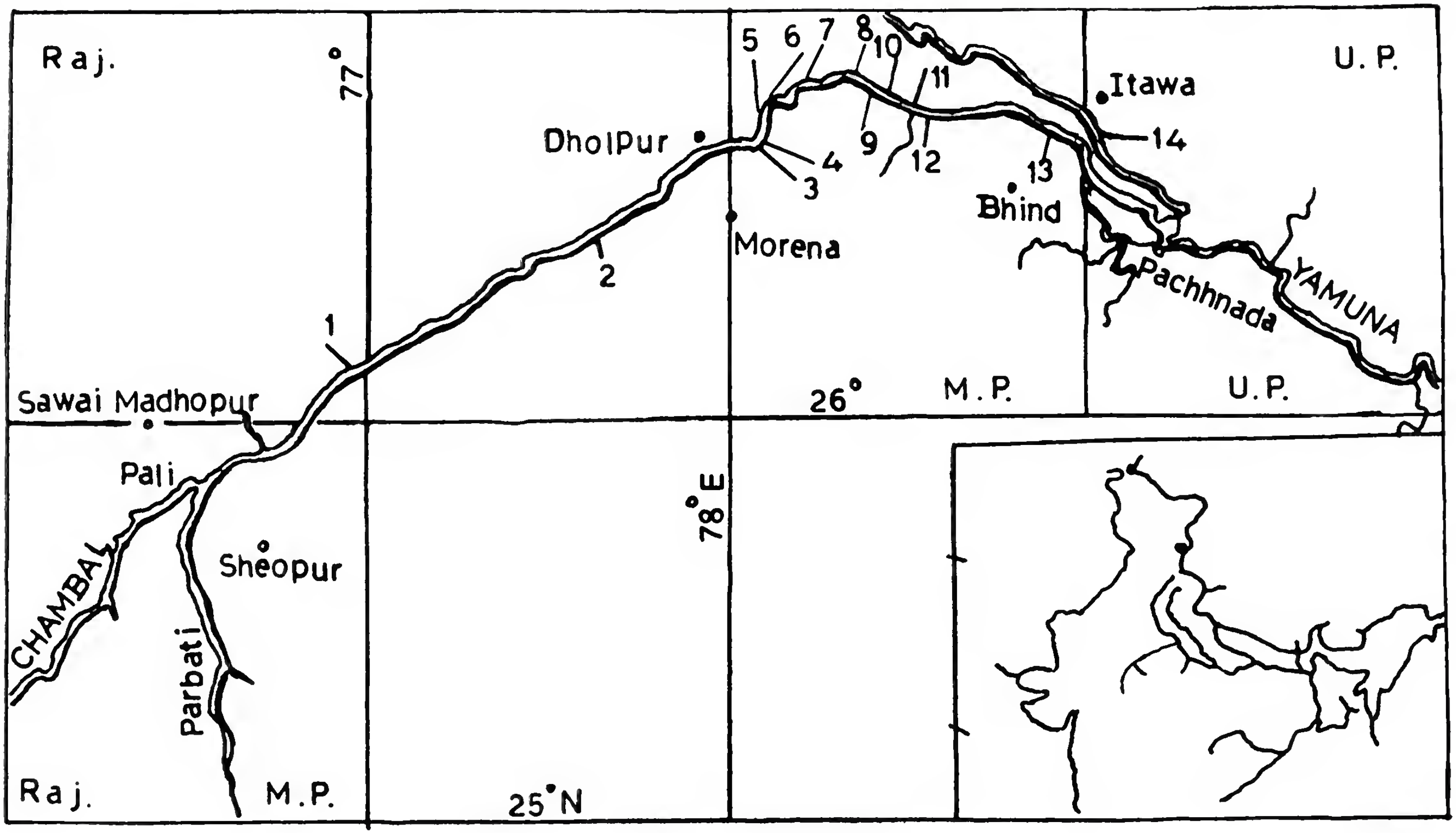

Fig. 1 National Chambal Sanctuary from Pali to Pachnada showing the gharial release sites (1, 2, 4, 5, 8, 10, 11) and the study area (commencing from 3 and extending upto 14) where the gharial survey work was undertaken.

1. Baroli; 2. Chinnoni; 3. Bhavesuri; 4. Kuthiyana; 5. Pureni; 6. Barsala; 7. Holapura; 8. Barenda; 9. Usedghat; 10. Jeoraghat; 11. Kenjaraghat; 12. Nagraghat; 13. Ranipura; 14. Gyanpura. M.P. — Madhya Pradesh; Raj. — Rajasthan; U.P. — Uttar Pradesh.

TABLE 1

NUMBER OF GHARIAL RELEASED IN THE STUDY AREA (BHAVESURI TO GYANPURA) DURING 1979-1981

Month and Year	Release in study area Place	Number		Release up-stream study area Place	Number	Release down-stream study area Place	Number
May & December 1979	Jeora	45	(May 15) (Dec. 30)	x	x	x	x
November & December 1979	Barenda	30	(Nov. 15)	x	x	x	x
February 1980	Barenda	15	(Dec. 15)	x	x	x	x
March 1980	Pureni	50		x	x	x	x
March 1980	Kenjara	45		x	x	x	x
March 1981	Kuthiana	44		Baroli	83	x	x
March 1981	Kenjara	43		Chinnoni	83	x	x
	Total	272			166	Nil	

TABLE 2

GHARIAL COUNTS IN 1981 WITH REFERENCE TO RELEASES IN NORTH NATIONAL CHAMBAL SANCTUARY

S. No.	River stretch	Total number of Gharial	Size composition above 9′	5′–8′	2′–5′	below 2′	Total number of gharial released between 1979-81
1	Bhavesuri to Pureni (6.10.1981)	51	7	37	4	3	94(44)
2	Pureni to Barsala (7.10.1981)	17	–	14	1	2	–
3	Barsala to Holapura (8.10.1981)	23	1 gharial and 2 mugger	18	4	–	–
4	Holapura to Usadghat (9.10.1981)	25	–	21	2	2	45(0)
5	Usadghat to Nagra (10.10.1981)	28	3	20	2	3	133(43)
6.	Nagra to Ranipura (11.10.1981)	16	–	16	–	–	–
7	Ranipura to Gyanpura (12.10.1981)	14	3	9	1	1	–
	Total	174	14 gharials 2 muggers	135	14	11	272(87)

Bracketed figures in the second column show the date of survey. Figures in brackets in the last column indicate number of gharials released during 1981 before census.

Study Procedure

The survey was conducted on the Madhya Pradesh bank from upstream to downstream by me and on the Uttar Pradesh side by a field assistant. Visual count was made of the Gharials basking and their approximate size-group was noted.

Results and Discussion

Gharial counts in the study area are presented in Table 2. The maximum population of Gharials resides between Bhavesuri and Nagra (Stretches 1-5). The highest number of Gharial located was from Bhavesuri to Pureni (Stretch 1), where 44 out of 160 small and medium size gharials were observed. This large number may be due to the Gharials released in this area. The minimum number of Gharials found in the study area-7 might be due to human activities in this area.

Based on a survey conducted in 1975/1976, Singh (1982) recorded about 10 isolated adult gharials in River Chambal in U.P./M.P. area. Basu and Choudhury (1982) stated that a total of 73 Gharials were observed in the Chambal river during their survey in 1976-78. However, the large counts made in the present study is a result of 'grow and release programme'. The results of the present study also indicate that effective protection measures were followed in the Sanctuary. However, the results in the present study reveals that the distribution of Gharial population is influenced by the habitat destruction in certain areas.

A thorough survey should be conducted along the entire Chambal river to identify favourable habitats for Gharial release in the future.

Acknowledgements

I thank the Chief Conservator of Forests (WL), Madhya Pradesh for giving permission to carry out the study in the National Chambal Sanctuary. I am grateful to Dr L. A. K. Singh (Crocodile Research Centre, Govt. of India) for his encouragement, guidance and critical correction of manuscript. Thanks are due to Sri R. J. Rao (CSIR Senior Research Fellow, Bhopal) for his valuable suggestions in preparing the manuscript. I am also grateful to the field staff of Uttar Pradesh who had assisted me during the census and with whom I participated in the gharial release programme.

National Chambal Gharial Sanctuary,
Deori, Morena (M.P.),
March 30, 1984.

R. K. SHARMA

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(Dec. 30)

28. OBSERVATIONS ON THE BANDED KRAIT, *BUNGARUS FASCIATUS*

Like many other Indian snakes, information on the various ethological aspects of the Banded Krait is very scanty (Whitaker 1982) I observed a Banded Krait in the vicinity of a pond at Nazramohamda (Darbhanga District, Bihar) on 20th July, 1984. The snake was apparently full grown and had bright and beautiful yellow and black bands quite conspicuous in the grassy background. Several village boys had already seen the snake before I saw it and the snake appeared a little nervous due to their presence. I observed the snake from 0815 to 0930 hrs and whenever I approached closely for photographing, the snake hissed loudly but did not strike at any time. Finally it disappeared into the thick grass.

The local people report to this snake as a resident in this locality seen at times with young.

The snake is locally known as 'Ganguar' and as mentioned by Biswas (1984) it is protected by the local people in this area as it is supposed to bring prosperity to the house by its presence in the vicinity. It is also a common belief in this area that other snakes do not live in the area where the Banded Krait resides. Probably this belief supports the fiindings of Traill (1895, Editor's note), Evans (1902) and Wall (1903) .

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29. REPLACEMENT NAMES FOR TWO INDIAN SPECIES OF *PHILAUTUS* (ANURA: RHACOPHORIDAE)

Rao (1937) described 8 new species of *Philautus* from southern India, but none of his materials are available for study. Probably, the types of all the new species have already been lost. However, the names of two of the species out of eight *Philautus* described as new by Rao (1937), are found to be preoccupied. So I provide here replacement names for the two species.

Philautus crnri nom. nov.

Original name: *Philautus longicrus* Rao, 1937.

Type locality: Kempholey, Hassan (Mysore).

The name *Philautus longicrus* has already been preoccupied by *Ixalus* (=*Philautus*) *longicrus* which has been described by Boulenger (1894) from Palawan, Borneo.

ETYMOLOGY

The new name has been given after C. R. N. Rao, for his contributions to Indian Herpetology.

Philautus hassanensis nom. nov.

Original name: *Philautus montanus* Rao, 1937.

Type locality: Hills of Kempholey, Hassan (Mysore).

This species has also been preoccupied by *Philautus montanus* described by Taylor, 1920 from the Mount Bongao, Bongao Island, Sulu Archipelago (Philippines).

ETYMOLOGY

The new name has been given after Hassan, which is the type locality of this species.

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August 27, 1984.

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30. NOTES ON THE CORRECT SPELLING OF THE INDIAN BULL FROG, *RANA TIGERINA* DAUDIN

There is considerable confusion regarding the correct nomenclature of the Indian bull frog. In most of the scientific publications on this species, it has been referred as *Rana tigrina*. But, Daudin (1803a, 1803b) used *tigerina* in the original description of the species. Merrem (1820) for some reason changed the spelling to *tigrina*. Boulenger (1882) followed the misspelling, *tigrina* as provided by Merrem (1820). Most of the workers after Boulenger (1882, 1890 and 1920), followed the misspelling, *tigrina*, because perhaps Boulenger's publications were readily available for reference to most of the Indian biologists who were working on different biological aspects of *Rana tigerina*. As *Rana tigerina* is one of the laboratory animals used by most Indian biologists for experimental purposes, we find innumerable publications on this species dealing with different aspects of scientific investigations, but most of the workers are not aware about the correct spelling given by Daudin (1803). Even most of the systematic publications on the Indian amphibians contain the wrong spelling, *Rana tigrina*.

Stejneger (1907) even reverted the spelling to *tigerina*, but perhaps his publication was not accessible to most Indian workers.

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31. ON THE TYPE SPECIMEN OF *DANIO* (*DANIO*) *ANNANDALEI* CHAUDHURI, 1908 WITH A REDESCRIPTION OF THE SPECIES (PISCES: CYPRINIDAE)

(*With two text-figures*)

Chaudhuri (1908) described *Danio annandalei* from Lower Burma. While discussing its affinity emphasis was given to the presence or absence of scaly appendages at the bases of paired fins, but having examined all of the species from the Indian region it has been found that it is not a unique feature as considered by Chaudhuri. Further the presence of preorbital spinous process in this species seems to have been overlooked by the earlier workers. This species, therefore, is redescribed here based on this finding.

INTRODUCTION

Chaudhuri (1908) described *Danio annandalei* collected from a jungle stream near Kawkareik, at the base of Dawna Hills in Tenasserim, Lower Burma. He gave a detailed description of the colour pattern of the species which is not very different from that of *Danio* (*Danio*) *dangila* (Hamilton), and in establishing the relationships of the species gave much importance to the presence or absence of scaly or fleshy appendages at the bases of paired fins. Examination of all the Indian species reveals that all species of *Danio* possess scaly or fleshy appendages at the bases of paired fins. It is worth mentioning that Hora & Mukerji (1934) also had opined in a similar manner. On the other hand while going

through a paper of Myers (1953) on the classification of the danios, it was found that certain remarks made by the author are very interesting in the light of the present author's work on the revisionary studies of the cyprinid genus *Danio* Hamilton. Myers (1953) stated that in 1937 while he was discussing Hora & Mukerji's principal paper on the danios he had pointed out that "its authors had failed to examine and distinguish two important characters which are present in several species and which almost certainly indicate relationship — the 'spines' over the eye (as in *Danio spinosus* Day) and the strange 'preorbital spine' a protuberance on the front rim of the orbit".

In another paper Herre and Myers (1937) commented, "The fact that the preorbital process has been almost completely overlooked in so common a species as *Danio aequipinnatus* (McClelland)". These comments have induced me to examine all the species of the genus *Danio* in the collection of the Zoological Survey of India. In the course of this examination I found that *Danio (Danio) annandalei* Chaudhuri, has the character of the backwardly directed preorbital spinous process on the front rim of the eye socket. The preorbital structure derived from the lachrymal bone of the orbit in some of the species of the genus *Danio* had been considered of sufficient generic importance by Chu (1935) to erect a new genus *Danioides* with *Danio khienensis* Anderson, from Yunnan, as the type species and of subgeneric importance by Fowler (1934) to describe a new subgenus *Rambaibarnia* with *Danio regina* Fowler, from the peninsular Thailand, as the type species. Based on my findings the species is redescribed and illustrated for the first time.

Danio (Danio) annandalei Chaudhuri

Danio annandalei Chaudhuri, 1908, *Rec. Indian Mus.*, 2(2): 125 (type locality: Dawna Hills, Tenasserim, Lower Burma).

Danio annandalei, Myers, 1924, *Am. Mus. Novit.*, *150*: 2 (Review of *Danio*).

Danio (*Danio*) *annandalei*, Hora and Mukerji, 1934, *Rec. Indian Mus.*, *36*(1): 134 (synoptic table to species of the genus *Danio*).

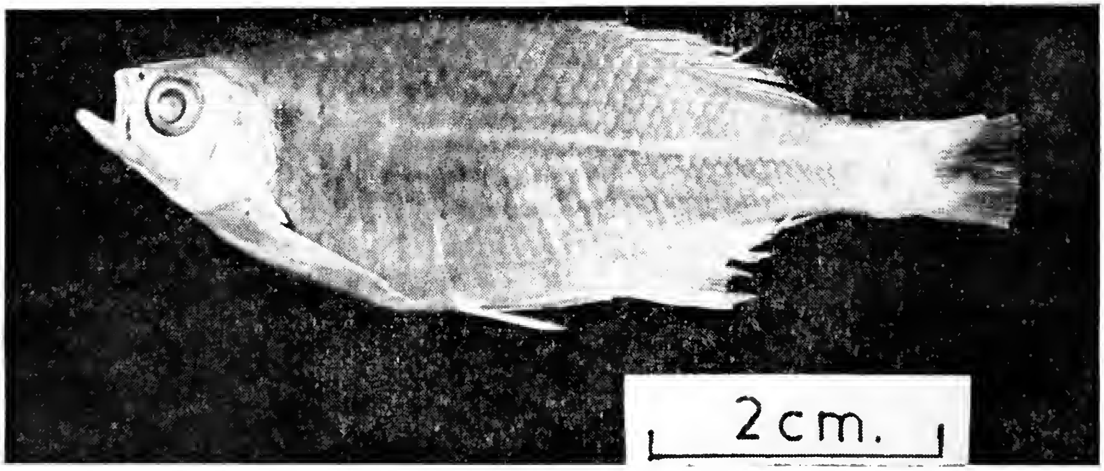

Fig. 1. Lateral view of one of the syntypes of *Danio* (*Danio*) *annandalei* Chaudhuri

Material examined. Syntypes (Fig. 1): ZSI F 1599/1, 2 exs., 55 mm.-57 mm. S L.; jungle stream at the base of Dawna Hills, Tenasserim, Lower Burma; N. Annandale.

Other example: ZSI F 11496/1, 1 ex. 59 mm. S.L.; Western drainage of the Pegu Yomas, Upper Burma; V. P. Sondhi; 9.4. 1934.

Diagnosis

Head length 3.80-3.93 and body depth 2.85-3.10 in standard length. Eye diameter 3.11-3.33 in head length, provided with a small backwardly directed spinous process at the anterior rim of the orbit (Fig. 2). Least height of caudal peduncle 1.57-1.69 in its length. Lateral line scales 54-56. Barbels 2 pairs.

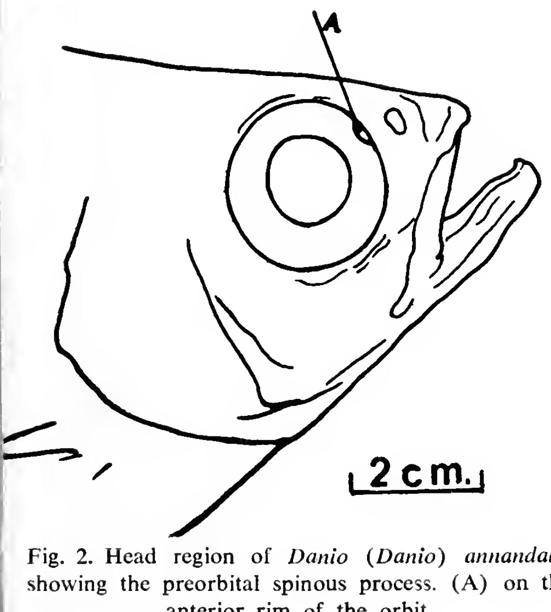

Fig. 2. Head region of *Danio* (*Danio*) *annandalei* showing the preorbital spinous process. (A) on the anterior rim of the orbit.

Description

Head length 3.88 (3.80-3.93), body depth 2.94 (2.85-3.10), predorsal distance 1.75 (1.71-1.78), prepelvic distance 2 10 (2.03-2.18), caudal peduncle length 5.18 (5.00-5.36) in standard length. Least height of caudal peduncle 8.34 (8.14-8.46) in standard length, 1.61 (1.57-1.69) in its length. Height of head 1.00 (1.00-1.00) and width of head 2.00 (1.87-2.14) in head length. Eye diameter 3.25 (3.11-3.33) in head length, 1.33 (1.33-1.33) in interorbital width. Eye is provided with a small posteriorly projecting preorbital spinous process on the front rim of the eye socket derived from the lachrymal bone. Snout length 3.66 (3.50-3.75) in head length, 1.50 (1.50-1.50) in interorbital width. Barbels 2 pairs, anterior or rostral pairs half eye diameter and posterior or maxillary pairs much shorter than rostral pairs.

Scales 54-56 in the lateral line, lateral transverse row of scales 14, scales between lateral line and base of pelvic fin 3½. Predorsal scales 17-18 and circumpeduncular scales 18.

Fins. Dorsal rays ii, 13-14; Anal rays ii, 15-16; Pectoral rays i, 12; Pelvic rays i, 7. Height of dorsal 5.18 (5.00-5.36), height of anal 6.33 (6.11-6.55), pectoral length 4.38 (4.23-4.53), pelvic length 7.12 (6.87-7.37) in standard length. Both the paired fins possess scaly or fleshy appendages at their bases.

Colour in alcohol. Three longitudinal silvery coloured bands extending from head to base of caudal fin. A dark notch present at the superior margin of gill opening.

Distribution. Burma: Dawna Hills, Tenasserim, Lower Burma and Pegu Yomas, Upper Burma.

Relationships

Danio annandalei is related to *Danio spinosus* Day in having the preorbital spinuous

process on the anterior margin of the orbit and lateral line scales 54-56 but can be easily separated from the latter by the absence of the supraorbital spine which is directed anteriorly. Further the two species are different in the colour pattern of the body.

Remarks. Chaudhuri (1908) gave the lateral line scale counts 46-50 and he did not mention anything about the body depth. Further the original description lacks any illustration which is required to identify the species.

ACKNOWLEDGEMENTS

I thank Dr. B. K. Tikader, Director, Zoological Survey of India for laboratory facilities and Dr. K. C. Jayaram, Joint Director and Dr. P. K. Talwar, Superintending Zoologist, Zoological Survey of India, Calcutta for their valuable suggestions in preparation of this paper.

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32. SOME OBSERVATIONS ON THE SALINITY TOLERANCE OF MARINE FISHES AT THE TARAPOREVALA AQUARIUM, BOMBAY

The Taraporevala Aquarium, Bombay, is one of the large, popular public aquaria in India which exhibits live marine fishes. Unlike some of the public aquaria (for example the one at Monaco), the Taraporevala Aquarium maintains a closed circulation; that is, the sea water once pumped in is not circulated just once and then thrown back into the sea. Instead, the same sea water after passing through display tanks is recirculated again and again through the slow sub-sand filters which are about 2 metres in height.

The total sea water capacity at the Taraporevala Aquarium is 5,68,750 litres of which, the 18 marine display tanks comprise 86,450 litres. Below the room in which are housed the pumps and compressors, are the underground reinforced concrete reservoirs, one for fresh water and the other for sea water. The sea water reservoir which has a capacity of 1,91,100 litres is partitioned from the freshwater reservoir by a reinforced concrete wall.

From the fifth to the eighth August, 1984, very high mortality was noticed in the lobster tank. It was surmised that it could have been either due to copper sulphate in the sea water circulatory system or due to low salinity. Copper sulphate is used as a medication to cure common marine fish diseases such as the dinoflagellate *Oodinium* (Marine White Spot) and the ciliate *Cryptocaryon*. The concentration for treatment is 0.4 parts per million (ppm) of $CuSO_4$ (i.e. 1 ppm of Cu (Copper) ion, made by adding one drop/3.5 litres of a 4% solution of $CuSO_4$). The chemical, though not lethal to fishes at the concentration used, is highly toxic to invertebrates.

The possibility of high percentage of copper sulphate as the cause of mortality of the lobsters was ruled out as new sea water was taken in just before the rainy season (May 26 to May 28, 1984). This was done as it is not advisable to take in sea water during the rainy season because of low salinities due to dilution of sea water by fresh water, thrown into the Chowpatty Bay from the storm water drains and sewers. From 28th May to the 5th August, 1984, only about 80 ml of 30% copper sulphate solution was added in eight marine tanks (but not in the lobster tank) and that too only for a period of 24 hours. The water from each of these tanks was then drained off into the circulatory system.

In view of the improbability of copper sulphate being the causative factor of mortality, the only other possibility was low salinity. The salinity of samples of sea water taken at three different places in the circulatory system was found to be 11 parts per thousand (ppt). The salinity of the sea water instead of showing the expected increase due to evaporation, had actually decreased, yet the marine fishes were not showing any signs of distress such as listlessness, loss of appetite, etc. On investigating into the cause of low salinity, it was found that water from the underground freshwater reservoir was seeping into the sea water reservoir through cracks in the dividing wall and this was instrumental in lowering the salinity. Sea water samples from the Chowpatty Bay were tested for salinity on 9th August, 1984 and showed a salinity of 27‰. It was, therefore, decided to pump in fresh sea water immediately into the circulatory system so as to alleviate any physiological imbalance to the fish.

Jayaram (1981, p. 3) in his book FRESH WATER FISHES OF INDIA .... A HANDBOOK, has also included several brackish water fishes; he has given as his reason for this the observation that "they are either visitors or inhabitants of estuaries. They do occur in the freshwater zone of the rivers and may even extend beyond that zone. These are listed under the sub-heading 'species visiting Fresh Water.' The above statement of Jayaram corroborates our observation regarding the tolerance of marine fishes to low salinities.

The sharks (*Carcharias* spp.), stingrays (*Dasyatis* spp.), Butterfly fish (*Chaetodon collaris*), Parrot fish (*Platyglossus* spp.), Bat fish (*Platax teira*), Sergeant Major (*Abudefduf sextilis*), Cat fish (*Arius* spp.), Surgeon fish (*Acanthurus strigosus*), Pseudo Pomfrets (*Trachynotus ovatus*), Jig saw puzzle fish (*Siganus* spp.), Spotted grouper (*Epinephalus* spp.), File fish (*Tricanthus brevirostris*), spotted dory (*Drepane punctata*), *Therapon jarbua* and *Monodactylus* spp. — which are normally considered to be "marine" fishes, were found by this experience of ours, to be able to tolerate substantial dilution of sea water in which they live, thus refuting the popular belief that these fishes are very sensitive to changes in salinity.

CURATOR,
TARAPOREVALA AQUARIUM,
NETAJI SUBHASH ROAD,
BOMBAY 400 002.

A. M. ANDHARE

TARAPOREVALA AQUARIUM,
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V. N. HEGDE

33. EXTENSION OF RANGE OF THE ESTUARINE CRAB *ILYOPLAX GANGETICA* (KEMP) TO THE WEST COAST OF INDIA

(*With a text-figure*)

Mr. S. K. Alam and Mrs. S. S. Borgaonkar sent me specimens of a crab for identification, which they had collected from Malad Creek and Thane Creek respectively. These turned out to be the estuarine crab *Ilyoplax gangetica* (Kemp).

This crab was first described by Kemp in 1919 based on two specimens from Matlah river in the Gangetic delta. He named these crabs *Tympanomerus gangeticus.* Like most species of this genus, these crabs frequent waters of low salinity, burrowing in clayey or muddy sand.

The crab belongs to the subfamily Scopimerinae (Mictyrinae of Tesch) of the family Ocypodidae. The name *Tympanomerus* was proposed by Rathbun in 1897 (*Proc. Biol. Soc., Washington 11*: 164) to replace de Man's generic name *Dioxippe* (1888; de Man, *Journ. Linn. Soc., Zool. 22*: 137) which is preoccupied. From as early as 1900, authors like Alcock (1900, p. 371), de Man (1908, p. 212) and Kemp (loc. cit., p. 336) have remarked on the inappropriateness of the name *Tympanomerus,* as only in *Tympanomerus pusillus* (de Haan) from Japan are small 'tympana' present on the meropodites of the last pair of legs. Tympana are curious thin-walled, membranous, elliptical areas on the meropodites of the walking legs, and sometimes on the thoracic sterna, of Scopimerine crabs. Kemp had correctly predicted (loc cit., p. 310) that *Tympanomerus* would be synonymous with *Ilyoplax* — a genus created by Stimpson in 1858 (*Proc. Acad. Nat. Sci., Philadelphia 10* : 98) for the species *tenella* from the Canton river in China. Finally, in 1921 Rathbun (*Proc. Biol. soc., Washington 34* : 156) considered that *Tympanomerus* and *Ilyoplax* were inseparable, the latter name having priority. Tweedie (1937) has given a key to the identification of crabs of the genus *Ilyoplax.*

Ilyoplax differs from *Dotilla* and *Scopimera* in having the last segment of the second maxilliped attached terminally to the penultimate segment, which is not expanded. It differs from *Dotillopsis* in the absence of sculpturing on the upper surface of the carapace and of deep convoluted sculpture on the lateral walls.

Ilyoplax gangetica is most closely related

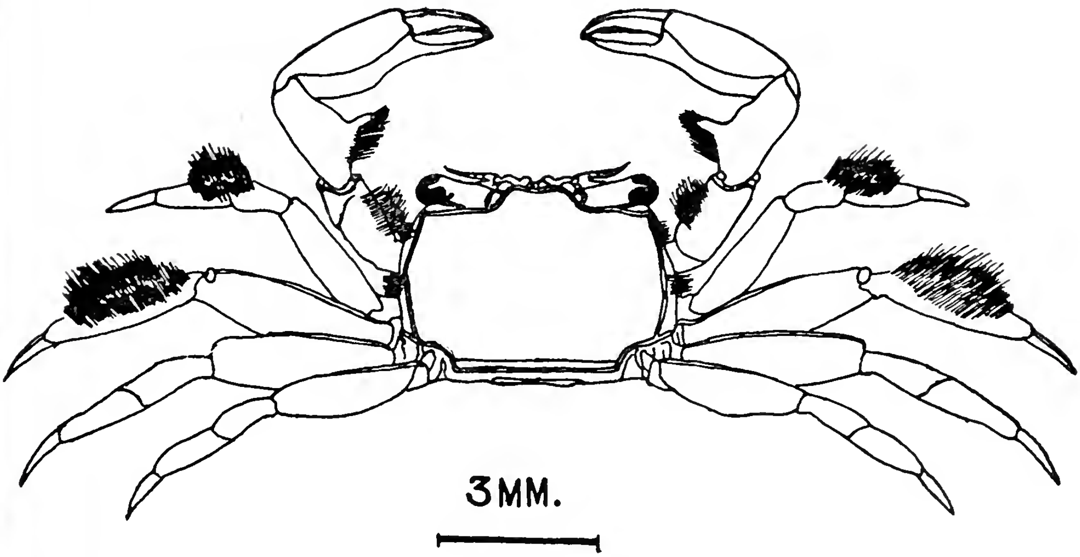

Fig. 1. *Ilyoplax gangetica* (Kemp).

to *I. orientalis* (de Man) from Mergui and *I. longicarpa* Tweedie from the west coast of Malay Peninsula. *I. gangetica* differs from *I. orientalis* in having the crest defining the lateral borders of the upper surface of the carapace being convex and not sinuous. The lower border of the orbit near its outer end does not have the large obtuse lobe found in *I. orientalis*. The chelipeds in the adult male are greatly elongated in *I. longicarpa*, but only moderately so in *I. gangetica*. Moreover, the ratio of length to anterior breadth of the carapace is 0.8 : 1 in *I. longicarpa*, but only 0.75 : 1 in *I. gangetica*.

Ilyoplax longicarpa, collected from Port Swettenham on the west coast of the Malay Peninsula, when first seen by Tweedie (1935), was identified by him as *I. gangetica*. Subsequently, when the specimens were compared with *I. gangetica* from the collections of the Indian Museum, Tweedie (1937) created a new species, *I. longicarpa*, for them.

The dimensions of a large specimen from Bombay are :

length of carapace	.... 8 mm.
breadth of carapace	.... 6 mm.

The present finding of the crab from the Thane creek extends its range of distribution to the west coast of India.

The junior author (S. S. B.) acknowledges thanks to Dr. (Mrs.) K. S. Gokhale for assistance in her studies.

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34. SOME OBSERVATIONS ON THE BIOLOGY OF JAPANESE MINT DEFOLIATOR, *SYNGAMIA ABRUPTALIS* WLK. (LEPIDOPTERA: PYRALIDAE)

Menthol, an industrial product used in pharmaceuticals and toiletries, is still obtained from the plant *Mentha arvensis* (Labiat.). Though cheap synthetic substitutes have been developed, but quality products still depend on natural menthol, because of slight variation in the aroma of the former. The last few decades have seen a considerable increase in the acreage under this crop and the country is now largely self sufficient in menthol. Since the leaves are the source of essential oil which on chilling yield menthol crystals, defoliators obviously make a big dent in the yield. *Mentha arvensis* harbours a large number of defoliators (Mathur and Anand 1964) of which *Syngamia abruptalis* is an important pest.

This insect has not received much attention in the past, because its host plant spectrum did not include many economic crops and, also because, the pest population did not cross the economic threshold. Only after the introduction and subsequent large scale cultivation of Japanese mint in Jammu and Punjab, that the importance of *S. abruptalis* as a pest was realised and control measures formulated.

For laboratory observations larvae and adult moths were collected from the field and maintained at room temperature. Larvae were reared in petri dishes.

The attack on mentha crop starts in mid July when humidity goes up after a few showers. The initial attack is restricted only to the leaf buds at the growing shoots. By mid August the population builds up considerably and reigns high till 2nd-3rd week of September followed by a decline never to rise again in the season. One of the important factors responsible could be the high parasite activity of a hymenopterous wasp (identification pending) in the field. The III instar larvae collected from the field on three dates: 23rd August, 20th September and 4th October, were parasitised to the extent of 6.25%, 75.00% and 6.64% respectively.

Like all other nocturnal lepidopterans the moths become highly active at dusk, performing one of the important functions, the oviposition. It is observed that more number of eggs are laid between dusk and midnight (63%) than during the latter half of the night (37%) and none during daytime. A marked preference for the undersurface of the leaves as compared to the upper surface or stem was noticed.

No. of eggs scored	On lower leaf surface	On upper leaf surface	On stem and leaf stalk
850	494(58.1%)	334(39.2%)	22(2.7%)

Since the eggs have soft chorion, the female moths look for the angular spaces and the lower surface of leaves offer such sites in plenty because of the relief veins. On the upper leaf surface eggs are laid only in the veinal depressions. Normally the eggs are laid singly but at times 3-5 are cramped up at one spot, sometimes partly overlapping, thereby obliterating the usual circular egg outline. An egg is pearly white, but as the development of embryo proceeds the colour changes to a dirty hue. A black spot is visible on one side, where the larval head develops. On the day of hatching the black head is clearly discernible through the thin transluscent chorion. The entire process of hatching takes 35-45 minutes and one can watch the larva nibbling its way out. A diurnal hatching pattern was observed in the eggs wherein maximum numbers hatched between 12 and 14 hrs.

The duration of egg and other immature stages is given below in the table.

In all there are five larval instars of approximately 14 days' duration. All the instars shun strong sunlight and prefer to occupy the undersurface of the leaf. Spinning habit is common to all of them. The first instar larva selects two elevated sites on the leaf surface and positioning itself inbetween/ weaves a silken canopy glueing the threads on the crest of the two sides. The tunnel so formed has a front opening and is kept clean even of the faecal pellets by dumping them out. The second and subsequent instars usually fold the leaf along the midrib and reside in it. The later instars at times spin 2-3 leaves together to make an abode, keeping the central area clean of the faecal pellets. On being slightly disturbed the larva has the habit of wriggling backwards in jerky movements; but on further jabbing it tries to move away at a fast pace. On strong shaking of the twig it descends to the ground like a spider. All the instars scrape the chlorophyll bearing tissue of the leaf, of course, in increasing quantity as they advance in age sparing the epidermis of the opposite leaf surface.

TABLE

DURATION OF IMMATURE STAGES

Stage	Duration (in days)	Range (in days)
Egg	2.98 ± 0.70	1–3
I Instar larva	2.50 ± 0.83	1–4
II Instar larva	1.89 ± 0.83	1–3
III Instar larva	2.24 ± 0.93	1–3
IV Instar larva	1.90 ± 0.40	1–3
V Instar larva	5.10 ± 0.30	5–6
Pupa	7.20 ± 0.40	7–8

In the first and second instars the larval head is black, but in third the head develops big brown patches which coalesce in IV and V instars turning the head completely brown. The larval body which in I and II instars is dirty white acquires a greenish colour in the III instar. In IV instar the abdominal segments 1-9 develop black patches at the base

of the abdominal setae. The V instar larva which grows to a length of 1.5 cm develops pink patches on the abdominal segments and is distinct from the rest of the early instars. Just before prepupation the entire larva turns pink but for the head which retains its deep brown colour.

For pupation the mature V instar larva drops to the ground and spins a cocoon. Sand grains are incorporated in the cocoon on the outside. Given an alternative of say filter paper pieces along with sand grains during cocoon spinning, the latter are preferred to the soft filter paper pieces. When moist and dry sand was provided no particular preference was shown to either of them. The pupal stage lasts for about 7 days.

In moth emergence no particular time pattern was noticeable between day and night hours. The moths are sluggish immediately after emergence but become active after 30 minutes or so. A high flying activity was noticeable only in 10-12 h old moths. Under normal laboratory conditions the moths remained alive for approximately seven days; however, in one solitary instance a moth survived for 16 days. In the 200 laboratory reared moths the ratio between ♂ and ♀ was 1 : 1.

While handling the larval stages of *S. abruptalis* an interesting observation was made by me. The larvae feed on mint foliage which on steam distillation yields 0.45% essential oil on fresh weight basis. The oil contains free menthol 65-70%, methyl acetate 15%, menthone 10% and other terpenes 5-10%. The first three chemicals which make the bulk of the oil are strong smelling, but surprisingly this smell is completely absent from the faecal pellets indicating that the larva has been able to convert and degrade the entire quantity of aromatic chemicals to highly polar compounds for excretion. There is no sequestering of these components either in the larval body as is seen by the absence of characteristic smell.

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Reference

Mathur, A. C. & Anand, M. (1964): Pests of Medicinal Plants. In 'Entomology in India'. E.S.I., New Delhi.

35. FAMILY HALORAGACEAE IN THE NORTH WESTERN HIMALAYAS

Haloragaceae, a natural group of plants with about 6 genera and 120 species, represented by a single genus in our area.

Myriophyllum L. Sp. Pl. 992 (1753).
A genus with about 45 species, cosmopolitan in distribution. It is represented by about 3 species in the local flora, forming dense mats in the bottom of all the deep water lakes in association with *Ceratophyllum demersum* and *Nymphoides peltatum*. It is very common

in the Wular and the Manasbal lakes. The pollen grains of both the species (*M. spicatum* and *M. verticillatum*) are almost similar, except that in *M. spicatum* where the exine arises at the pores gradually, so that the aspids are lower, wider and rather more poorly defined. The grains are 3-5 aperturate, oblate-oblate spheroidal, showing some resemblance with terrestrial Onagraceae, but differs markedly from its related family Callitrichaceae in the absence of exine bacculation — a characteristic feature for the family Callitrichaceae. There is a slight resemblance in the pollen grains of *Myriophyllum*, *Alnus* and *Betula* (Wodehouse 1935). Auer, 1953 has studied the pollen grains of *Myriophyllum* of European deposits.

KEY TO THE SPECIES

1. Marsh herbs; spikes thickly leafy, more than 10 cm long. Flowers in the axils of leaf like pectinate bracts; bracts much longer than the flowers. Leaves usually five in a whorl .... *M. verticillatum*
1. Aquatic herbs; spikes mostly naked, less than 10 cm long; Flowers in the axils of entire bracts; bracts shorter than the flowers. Leaves usually four in a whorl
   2. Leaves 2-4 in a whorl, pinnately divided into 6-14 pairs of capillary segments, 4-5 mm long. Fruit subglobose, 2 × 1.8 mm, tubercled, carpellary bracts acute, keeled .... *M. tuberculatum*
   2. Leaves 3-5 in a whorl, pinnately divided into 25-39, long acicular, acute segments, 0.2 × 2.5 cm long. Fruit globular 2.2 × 2.5 mm, muricate, carpellery bracts obtuse, round .... *M. spicatum*

Myriophyllum spicatum L. Sp. Pl. 992 (1753); Clarke, Fl. Brit. Ind. 2: 433 (1878); Schindler, Das Pfanzen. 23 : 90 (1905).

Rhizomatous, emerged, prostrate herbs, can be readily distinguished in the field in having leaves in whorls of 2-3, pinnately divided into 25-39 long, acicular, acute segments. Spikes aerial, upper portion staminate; lower prostrate; stamens 4, ovary tetragonal with 4 deep furrows; stigma 4, plumose. Fruit globular, 2.2 × 2.5 mm, black, dehiscing by 4 longitudinal sutures. Nuts trigonal with 2 flat sides and an outer convex side, black. Pollen grains tetraporate, oblate, spheroidal, 30.9–26.0 × 27.3-23.4μ; exine 1.3μ thick; sexine as thick as nexine, intine thin, pores 2.6μ dia., oval, aspidote, meshes of the reticulum obscurely circular.

Common in lakes, ponds, slow running streams. Leper Hospital (Nagin lake) A. M. KAK, 3557, 3723, 3862; Manasbal lake A. M. KAK, 606, 3042; Nilang lake, A. M. KAK, 2008; Dal lake (Ruph tank) A. M. KAK 610.

Distribution. Cosmopolitan.

The land forms of this species are common. When the water recedes in the ponds and channels, a dense turf of these plants is seen, with dwarf, unbranched stems, rooting profusely from the nodes. The leaves are also smaller, broader and thicker, few in number than those of the submerged species.

Myriophyllum verticillatum L. Sp. Pl. 992 (1753); Schindler, l. c. 37; Clarke, l. c. 433.

A perennial herb of marshlands. Leaves dimorphic; submerged ones pinnately divided, 4-6 in a whorl; each divided into 22-28 linear, pectinate fleshy segments aerial ones smaller, never regularly divided, spikes 13-23 cm long. Flowers uni- or bisexual — all stages of sex distribution occur within the same individual; sometimes the whole spike bears bisexual flowers, in some cases the bisexual flowers are in the centre, male above and female below. In certain cases male and female flowers are borne on the same node; stamens 8, stigma 4. Fruit a globular nut, 3-5 × 3 mm, smooth with persistant stigma. Pollen grains 3-4 porate, subprolate 27.3–22.1μ; exine 2.6μ thick; sexine as thick as nexine, intine thin;

pores 2.6μ dia. oval or elliptical, aspidote, meshes of the reticulum obscurely circular, fine.

Common in swamps and marshes on the sides of lakes in irrigating channels. Shalimar, A. M. KAK 828; Anchar lake, A. M. KAK 830; Bemna, A. M. KAK 696.

Distribution. Europe, N. Africa, America, N. Asia, Kashmir.

The vegetative forms of the species persist throughout the year, even under the thick cover of snow. The species seems to be a recent introduction in the valley. S. C. Koul (1946) reports that some 20 years ago he had not seen a single plant in the Dal lake (Kashmir), but when he made further exploration he found this species widely distributed in the lake. It is obvious that the species is an adventive introduction through human agency from Europe.

Myriophyllum tuberculatum Roxb. Fl. Ind. 1: 451 (1832); Schindl., l. c. 96; Clarke, l. c. 432; Subramanyam Aq. Ang. **17** (1962).

Dwarf, simple herbs can be easily distinguished from the other species in having stems angular near nodes. Leaves dimorphic; submerged ones 2-4 in a whorl, pinnately divided into 6-14 pairs of capillary segments, 4-5 mm long; upper ones much shorter; spikes aerial 3-7 cm long. Flowers mostly unisexual; stamens 8, exerted; ovary 4 locular; stigma plumose. Fruit subglobose, tubercled, 2 × 1.8 mm with the outer convex faces. Rare near swampy and marshy places. Leper Hospital (Nagin lake) A. M. KAK 3552; Dal lake (floating islands) A. M. KAK 3967.

Distribution. Europe, N. America, Asia, India, Kashmir.

The species has been recorded for the first time from the area and is confined only to the Dal lake area. It seems that the species is the most recent introduction in the valley and makes us to believe that the seeds have been introduced through human agency from Europe and America.

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February 26, 1981.

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36. *ABELMOSCHUS ANGULOSUS* WALLICH EX WIGHT AND ARNOTT IN THE FORMER BOMBAY PRESIDENCY AND ITS COLLECTION AFTER 73 YEARS

Theodore Cooke (1958) included *Abelmoschus angulosus* Wall. ex Wight and Arnott (= *Hibiscus angulosus* Steud.) in his THE FLORA OF THE PRESIDENCY OF BOMBAY on the basis of a single collection made by Stocks from Konkan and commented 'the only specimens I have seen from Bombay are those marked as above (Konkan : Stocks)* in Herb. Kew. The plant does not seem to have been found by any other Bombay collector.

There is a single specimen of this species in the Herbarium of the Botanical Survey of India, Western Circle, Pune (BSI) collected by Talbot from Mahabaleshwar on 16th of October, 1905 (Talbot 4505) and recently correctly determined by J. van Borssum waalkes. Talbot (1976), however, did not include this species in his 'Forest Flora of Bombay Presidency and Sind'. There has been no further collection of this taxon from the Bombay Presidency either in the above Herbarium (BSI) or in the Blatter (BLAT) nor does exist any report in the literature surveyed for the Bombay Presidency on the occurrence and/or collection of this species though many parts of the Presidency have been centres of botanical interest to many a plant taxonomist since 1905.

I collected this taxon from Gurekhar, Panchghani on 26th of November, 1978 and the specimen (TSN 156208) along with its duplicates have been deposited in the Herbarium of the Botanical Survey of India, Western circle, Pune (BSI). It is apparent that this taxon is a rare one in the Presidency, though M.T. Masters in Hooker's FLORA OF BRITISH INDIA has Malabar and Nilghirris too as localities of its occurrence in India.

In the light of Cooke's remark about the doubtful occurrence of this species in the Presidency and of the fact that no collection of this species has been made for the last 73 years from the area, the present collection constitutes an important addition for the botany of the 'Presidency' in general and for that of the Maharashtra State in particular.

ACKNOWLEDGEMENTS

This work was carried out while I was working at Botanical Survey of India (WC), Pune on a Junior Research Fellowship from the Director of Botanical Survey of India and I thank him for the same; I am also thankful to the authorities of Blatter Herbarium for consultation facilities.

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March 23, 1984.

* Words in parenthesis by the author.

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37. A LITTLE KNOWN PLANT FROM SOUTH INDIA

Critical studies of the genus *Entada* Adans. based on herbarium specimens deposited at various herbaria in India, have revealed that two species occur in India, namely *E. pursaetha* DC. and *E. monostachya* DC. *E. pursaetha* DC. has been described in detail by many taxonomists in India. *E. monostachya* DC. is being reported here for the first time. It has been considered conspecific with *E. scandens* auct. (non Benth.) = *E. pursaetha* DC. by various taxonomists, namely Baker, in Hooker's FL. BRIT. INDIA (1879), Bentham in Revision of the suborder Mimoseae (1875), Brenan in *Kew Bulletin* 1955.

The specific epithet refers to the solitary inflorescence occurring in the species. Further it differs from *E. pursaetha* DC, in having leaflets with curved midrib dividing the lamina into unequal halves, bases unequal. leaflets falcate. slightly sickle shaped. These differences were noted by De Candolle as early as 1825.

Entada monostachya DC. Prodr. 2: 425, 1825. *Mimosa entada* Linn. Sp. Pl. 518. 1753.

A huge liana with branches and branchlets grey to brown. glabrous. Leaves bipinnate, alternate, rachis 4-5 cm long ending in bifid tendril, glabrous, grooved; pinnae 1-2 pairs, 5-15 cm long their racheses glabrous; leaflets 4-5 pairs, 2-5 cm long, 1-3 cm wide, stalked, stalk 1-2 mm long, falcate, slightly sickle shaped, midrid curved, bent dividing the lamina into unequal halves, apex retuse, emarginate, base oblique, midvein hairy in the beginning, later becoming glabrous. Flowers yellow. on axillary, solitary spike 10-15 cm long, axis pubescent. Calyx very small. Corolla exceeding the calyx. yellow 2-3 mm long. Stamens reddish, slightly exerted. Pods large 20-50 cm long, 5-8 cm wide. Seeds 4-10, compressed, smooth, orbicular.

Flowering. March-May;

Fruiting. Throughout the year.

Type. Rheede, Hort. Ind. Mal. 9: 151, t 77, 1689 (Lectotype); (Iconotype) De Candolle, 425.3 (G) Cotype.

Distribution. INDIA: South India: Kerala. Endemic.

Specimens examined. Kerala: Calder & Ramswamy 1466 (CAL); Bourdillon. Acc. no. 138918-19 (CAL); Calder 1408 (CAL); Subramaniyam 5624 (CAL); Henry 53231 (CAL); Narayanswamy 1227 (CAL); Tinnevelly Dist. Subramaniam 5624 (CAL).

BLATTER HERBARIUM,
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August 25, 1983.

RAVINDRA P. SUBHEDAR

38. *FICUS ALBIPILA* (MIQ.) KING (MORACEAE) — A NEW RECORD FOR INDIA

(*With a text-figure*)

Among 21 species of *Ficus* in the Flora of the Tamilnadu Carnatic (Mathew 1983: 1511-1532), two differed from the rest in the 2-fid styles (most species have undivided style) and by the presence of a pair of glands at the lowest nerve axil (most species have them at the base of the lamina near the petiole). These two species belong to subg. Pharmacosycea.

Of the two species, *F. nervosa* Heyne ex Roth was easily enough identified while the identity of the other remained uncertain. This latter was erroneously listed under *F. dalhousiae* Miq. in Matthew (1981).

Later, E. J. H. Corner (*pers. comm.*) identified this species as *F. albipila* (Miq.) King [too late for the Flora of the Tamilnadu Carnatic (Matthew 1983 : 1531), where it was referred to as *Ficus* sp.], pointing out that it was the first record not only for India but west of Thailand and the Malay Peninsula.

A detailed, illustrated account of the species (nomenclature, description, field notes, distribution and a documented list of specimens examined) is given below.

Ficus albipila (Miq.) King, Ann. Roy. Bot. Gard. (Calcutta) 2 : 179. 1888; Corner, Gard. Bull. Straits Settlem. (ser. 4) 21 : 29. 1965. *Covellia albipila* Miq. Fl. Ned. Ind. (suppl.) 175, 434. 1860. *Ficus* sp. Matthew, Fl. Tamilnadu Carnatic 3: 1531. 1983. *Ficus dalhousiae* Miq. *sensu* Matthew, Mat. Fl. Tamilnadu Carnatic 344. 1981.

Tree, (10) 15-20 m tall. Leaves alternate, broadly elliptic-ovate to cordiform, 15-30 × 9-18 cm, (sub) coriaceous, 3-5-nerved from base, lateral nerves 12-14 pairs, flattened above, raised below, intercostals obscure, softly pubescent below, base rounded to cordate, margin entire, apex gradually narrowed, shortly acuminate, cusp 1 cm, glandular in the axils of basal nerves; petiole to 8 cm; stipules lanceolate, to 3.5 cm, deciduous leaving annular scars. Fig(s) monoecious, axillary, 1 or 2, stalked, (sub) pyriform, 1-1.5 cm across, puberulous, top truncate; peduncle to 5 mm; basal bracts ovate-concave, 3.5 mm, puberulous without (sub) acute; orifice raised; internal bristles scaly, 1 mm, scarious. Tepals 3, ovate-concave, connate in ♀ flowers, 1.5 mm, cream with brown shade, glabrous. ♂ : disperse. Stamen 1, included; anther sessile, cells oblong, parallel, 0.5 mm; connective pouched, brown. ♀ : sessile. Ovary obovoid to bilateral, 1 mm, brownish; style filiform, 1.5 mm, 2-fid, curled. Gall flowers similar, pedicellate. Achenes smooth.

Tree with a crown of equal spread from the massive horizontal branches. Tender leaf greenish above, coppery below, thick coriaceous with age. Figs green, globose, pustulate.

Common in the dry and evergreen forests (400) 800-1300 m, generally erect, at times by rocks or even epiphytic.

Distribution. Thailand, Malaya, Sumatra, Borneo, Java, Timor, Queensland, New Guinea (Corner 1965, l.c.).

Specimens examined: TIRUCHI DIST. Pacchaimalais. Karuppankadu thittu (850 m) : RHT 3911: Kannimar shola (950 m): RHT 7037, 12486, 22601. *Salem dist.* Kollimalais, Arappuleeswarer Falls (1000 m): RHT 2198; be-

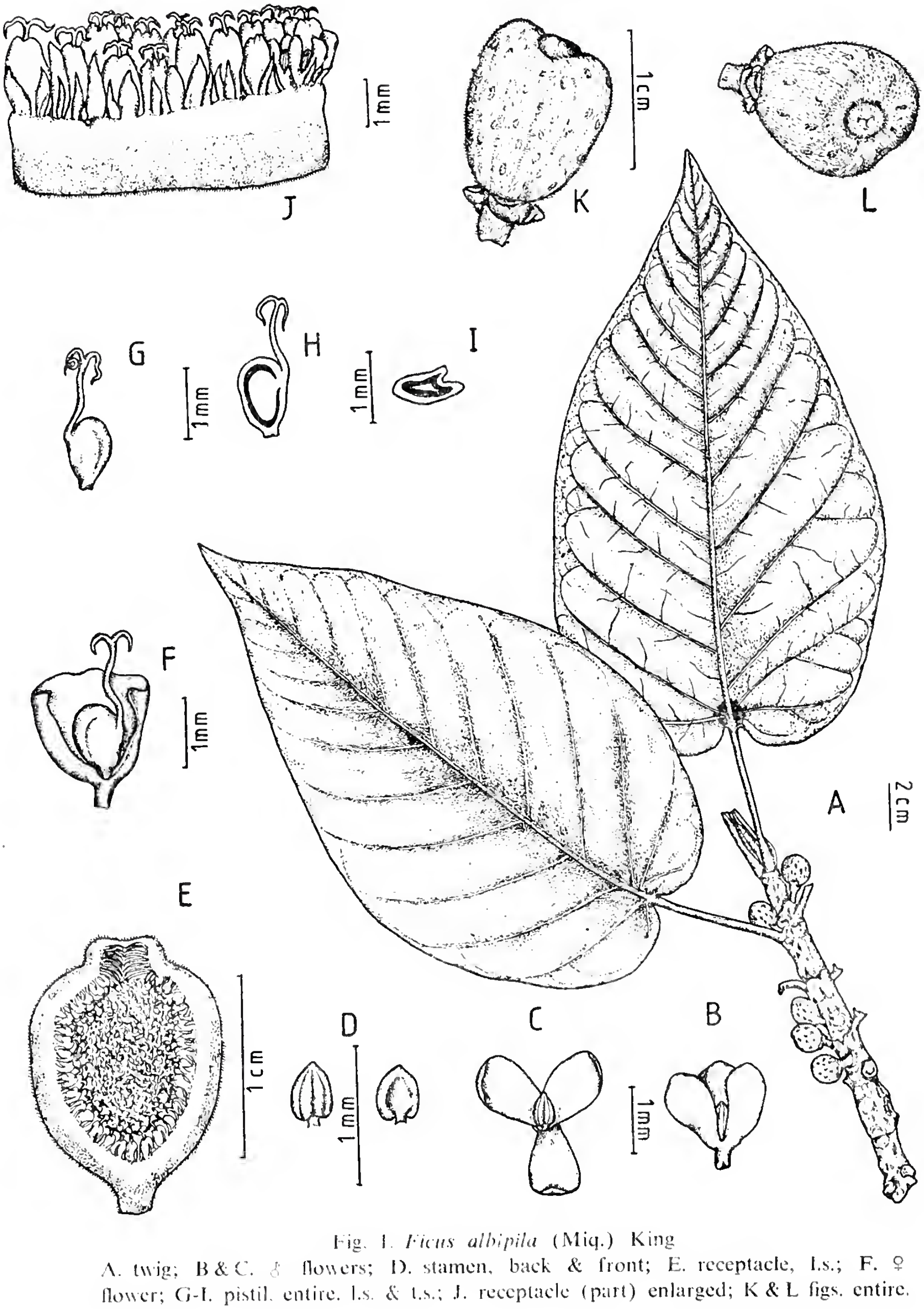

Fig. 1. *Ficus albipila* (Miq.) King

A. twig; B & C. ♂ flowers; D. stamen, back & front; E. receptacle, l.s.; F. ♀ flower; G-I. pistil, entire, l.s. & t.s.; J. receptacle (part) enlarged; K & L figs, entire.

low Solakkadu (1200 m): RHT 3071; Rasipuram slopes (400-850 m): RHT 15844, 15969, 22491; Periakalrayans, Nagalur (850 m): RHT 5455; Bodamalais, Melur (950 m): RHT 15391; Servarayans: ghat road (1300 m) RHT 23478; bridle path from Yercad down to Gundur (750 m): RHT 5083.

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April 18, 1984.

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39. ON THE OCCURRENCE OF *SCHOUWIA PURPUREA* (FORSK.) SCHWEINF. (BRASSICACEAE) IN ANDHRA PRADESH

While working at the Central National Herbarium (CAL), the authors have come across a specimen (Tadpatri, Anantapur District, Andhra Pradesh, *T. Pullaiah* F.A.P. 416, 6.x.1981) received for identification from the Herbarium, Department of Bio-Sciences, Srikrisnadevaraya University. The specimen, on critical examination, has been identified as *Schouwia purpurea* (Forsk.) Schweinf.

A native of Abyssinia, Egypt and Arabia, the species is widespread from Sahara to Arabia and N. E. Tropical Africa, and is a new introduction in India. In India, it is so far known from Maharashtra State, where it is said to be naturalised (Rao 1963, Thombre 1963). Recently, Bhaumik (*in press*) revised the genus for India and recorded its occurrence from Bellary and Chitradurga Districts of Karnataka. Thus, its occurrence from Anantapur District is recorded here as a new addition to the flora of Andhra Pradesh as well as its further extension of distribution towards the east. A detailed description of the taxon is provided here to facilitate its identity in the field.

Schouwia purpurea (Forsk.) Schweinf. in Bull. Herb. Boiss. 4. App. 2: 183. n. 486. 1896; Schulz in Engler & Prantl of Pflanzenr. 84 (IV.105): 53.1923; Thombre in J. Bombay nat. Hist. Soc. 60: 289. 1963. *Subularia purpurea* Forsk. Fl. Aegypt.—Arab. 117. 1775. *Thlaspi arabicum* Vahl. Symb. Bot. 2: 76. 1791 (excl. syn. Linn.). *Schouwia arabica* (Vahl) DC. Syst. Nat. 2: 644. 1821 et Prodr. 1: 224. 1824; W. J. Hook. Icon. Pl. 3. t. 223. 1840 (excl. pl. Sieb.); Rao in Bull. Bot. Surv. Ind. 5 : 265. 1963.

Annual, glabrous herbs, 25-75 cm tall. Stem erect, dicotomously branched from the base. Leaves 1.5-9 × 1-4 cm, simple, alternate, sessile. Basal leaves obovate or oblanceolate, tapering towards the base, acute at apex, crenately lobed or wavy-dentate to almost entire; upper leaves oblong-ovate or obovate, deeply cordate-auricled at base. Flowers purple, in terminal and leaf-opposed racemes, elongating up to 30 cm long in fruits. Sepals 4-5 mm long, outer-2 linear, inner-2 oblong-ovate, saccate at base. Petals 7.5-9 mm long, obovate or spathulate, clawed. Stamens tetradynamous, anthers linear, attenuate at the apex, sagittate at base. Siliqua 1.5-2 cm in diameter, sub-elliptic to ovate-orbicular, laterally compressed with a cordate base, reticulate and broadly winged; replum linear, membranous. Style persistant, pyramidal, 5-7 mm long, much shorter than the length of the valves. Seeds many, 2-seriate, globose, reddish brown, mucilagenous. Cotyledons conduplicate.

Fls. and Frts.: Jan. — Nov.

Ecology. In dry sandy soil, weed in cultivated fields.

ACKNOWLEDGEMENT

We thank the Keeper, Central National Herbarium for encouragement.

BOTANICAL SURVEY OF INDIA,
HOWRAH 711 103,
March 12, 1983.

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40. NOTES ON *MICROCOCCA MERCURIALIS* (LINN.) BENTH.

(*With a text-figure*)

Micrococca mercurialis (Linn.) Benth., a tropical Euphorbiaceous weed, has been recently observed occurring, quite frequently, in Greater Bombay as well as in some other parts of Maharshtra. The first record of this species from India is found in Hendrik Andrian van Rheede's HORTUS MALABARICUS vol. 10, p. 163, t. 82, 1703, under local name *Be-cupa-meni.* J. D. Hooker (1885), has reported it from Bihar and Deccan Peninsula and Gamble (1925) reported it from the Presidency of Madras. From Old Bombay Presidency, John Graham mentioned it in his CATALOGUE without any precise locality, whereas N. A. Dalzell and A. Gibson (1861) described it from Southern Concan and T. Cooke (1907) from Karwar and Porbandar.

This species considerably resembles *Acalypha indica* Linn. and was found mixed with various *Acalypha* species in Blatter Herbarium.

Due to the uncertainties regarding the localities mentioned by Graham (1839) and Dalzell & Gibson (1861), we consider this communication as a new record of this species from the present Maharashtra State. Complete synonymy and citations of literature consulted for identification of this species, description, illustrations of floral parts, and enumeration of specimens examined from different localities are given:

Micrococca mercurialis (Linn.) Benth. *ex* Hook. Fl. Nigritiana 503, 1849; Prain Ann. bot. 25: 631, 1911; Pax et Hoffman *ex* Engler et Prantl, Pflanzenreich. 4: 147 (6): 133, t. 18, f. D-F, 1912 & Planzenfam. 112, 1931;

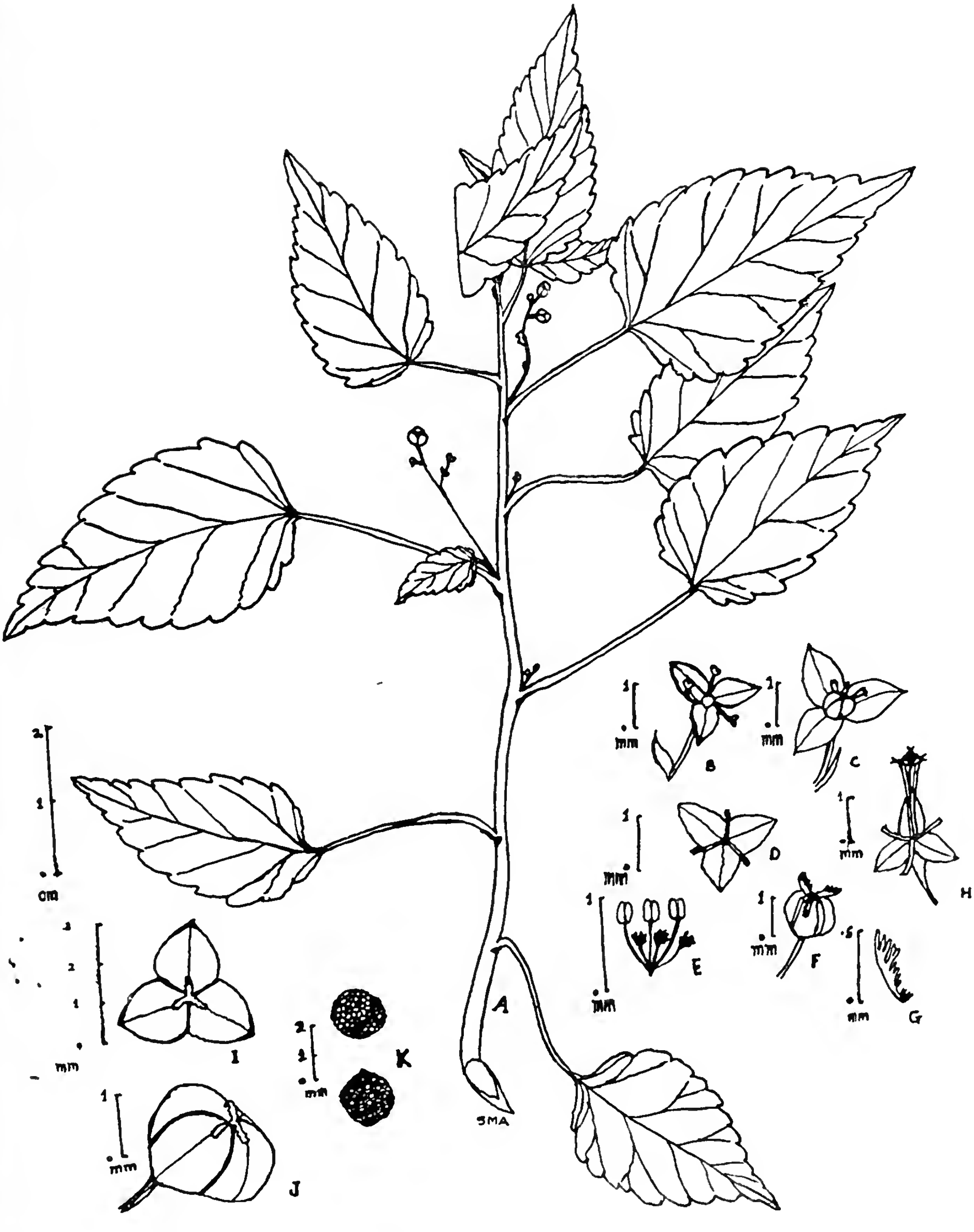

Fig. 1. *Micrococca mercurialis* (Linn.) Benth.
A. Flowering twig; B. Male flower; C. Female flower; 4. Dorsal view of perianth — male flower; E. Stamens and Staminodes; F. Pistil; G. Lacerate stigma lobe; H. Remnants of pistillate flower; I. Dorsal view of fruit; J. Lateral view of fruit; K. Seeds.

Gamble, Fl. Madras 7: 1327, 1925 (2: 928, 1956 in Repr. ed.); Tadulingam et Venkatnarayana, Handb. South. Indian Weeds 407, 1955; Santapau & Janardanan, Check-list in suppl. Bull. bot. Surv. India 8: 45, 1966 (Publ. 1967). *Tragia mercurialis* Linn. Sp. Pl. 2: 980, 1753; Graham, Cat. Bombay Pl. 186, 1839. *Microstachys mercurialis* (Linn.) Juss. *ex* Dalz. et Gibs., Bombay Flora 227, 1861. *Claoxylon mercurialis* (Linn.) Thwaites, Enum. Ceylon Pl. 271, 1864; DeCandolle, Prodr. 15: 790, 1886; J. D. Hooker, in Fl. Brit. India 5: 412, 1887; T. Cooke, Fl. Bombay Presidency 2: 609, 1908 (in repr. ed. 3: 107, 1958); V. D. Vartak, Enum. Pl. Gomantak, 94, 1966.

An erect, branched annual herb, 20-60 cm tall. Stem cylindric to obsurely terete, covered with fine hairs. Leaves simple, alternate, 2-5 cm long, ovate-lanceolate, sub-acute, crenate-serrate, rounded or sub-acute at base, with 5 (rarely 4) pairs of veins, glabrous above, minutely villose with white hairs below, petiolate. Petiole 0.7-1.6 cm long, slender, pubescent with minute hairs. Inflorescence axillary spikes. Main axis filiform, usually longer than the leaves, pubescent with minute white shining hairs. Flowers monoecious, unisexual, in clusters, distantly placed on the axis, bracteate. Each cluster consists of one female flower and 3-5 male flowers. Male flowers shortly pedicellate, bracteate. Bracts broadly ovoid, acute with a distinct mid-vein. Perianth lobes 3 (rarely 4), ovate, fleshy, acute, alternate, with small, linear, yellow appendages. Stamens 3, alternating with the perianth lobes; anthers 2-celled, divergent at the apex, filaments short. Staminodes 3, alternating with stamens. Female flowers bracteate; bracts ovate, acute at apex. Perianth lobes 3, broad, ovate, acute. Ovary hypogynous, tri-carpellary, trilocular, syncarpous, with single ovule in each locule. Style tri-lobed, lacerate. Fruit capsule, 0.3-0.4 cm in diameter, 3-lobed, each cocci bearing a single seed. Seeds sub-globose, pitted, minutely apiculate, foveolate, brown becoming black on drying.

Specimens Examined. M. R. Almeida: Azad Maidan, Bombay—520-526 (30.x. 1967), Goregaon — 529-36 (5.xii.1967), Fort, Bombay—1275 (20.viii.1970); Narayanan P.: Goa-305 (7.ix.1969); Santapau, H.: Bombay Reclamation — s.n. (27.iv.1942), Waltair, A. P. — 21344 (21.x.1956); Sedgwick, L. J. & Bell, T. R. D. — Karwar-6691 (Oct., 1919), 6752 (Oct. 1919), 6777 (Oct., 1919); S. Verghese: Fort, Bombay — s.n. (16.viii.1970); Wagh, S.: Shivadurg, A. P. — 6756-58 (1.viii. 1957), Guntur, A. P. — 3694 (4.ix.1956); Sinhvachalam-4395 (2.x.1956).

We thank the authorities of Blatter Herbarium, St. Xavier's College, Bombay (BLAT) and Western Circle, Botanical Survey of India, Poona (BSI) for permitting us to consult the herbaria and libraries, to Prof. P. V. Bole for going through the manuscript and suggesting some useful changes and, to Mr. M. R. Almeida for rewriting the paper in the present format.

BLATTER HERBARIUM,
BOMBAY.

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41. THREE SPECIES OF ORCHIDS NEW TO KERALA FORESTS

During the study of the Orchid flora of Kerala forests, we collected three species, namely *Dendrobium mablae* Gammie, *Smithsonia maculata* (Dalz.) Saldanha, and *Pomatocalpa mannii* (Reich. f.) J. J. Sm., which are additions to the flora of Kerala State.

Dendrobium mablae Gammie, *J. Bombay nat. Hist. Soc. 16*: 567, 1905; Santapau & Kapadia, Orch. Bombay 89, 1966; Saldanha & Nicholson, Fl. Hassan Dist. 821, 1976.

This species was collected from Chandranathode in Wynaad District, where it is common on *Wendlandia lawii* Hook. f. in the sholas near the grassland. The species resembles closely *Dendrobium nanum* Hook. f. and *D. anamalayanam* Chandrabose *et al.*, in the vegetative stage, but in the flower the lip is distinct with two rows of papillate hairs along the margin.

Specimen examined. Kerala State, Wynaad District, Chandanathode 800 m, 18-xi-1982; Sasidharan 2613.

Smithsonia maculata (Daltz.) Saldanha, *J. Bombay nat. Hist. Soc. 71*: 74, 1974, *et* Saldanha & Nicholson, Fl. Hassan District, 850, 1976; *Micropera maculata* Dalz., *J. Bot. Kew Misc. 3*: 282, 1851; *Gastrochilus maculatus* (Dalz.) O. Ktze., *Rev. Gen. Pl. 2*: 661, 1891.

This species was found growing on *Terminalia paniculata* Roth, in the moist-deciduous forests of Nelliampathy in Palghat District. The species has conspicuous yellow flowers. Its occurrence has been reported from other states of the Western Ghats. The present collection extends its range further south.

Specimen examined. Kerala State, Palghat District, Nelliampathy, 29-ii-1983, Mukteshkumar 2921.

Pomatocalpa mannii (Reich. f.) J. J. Sm. in *Nat. Tijd. Ned. Ind. 72*: 105, 1912; *Cleisostoma mannii* Reich. f. in Flora 55: 274, 1872; Hook. f. Fl. Brit. India 6: 74, 1890; Fischer in Gamble, Fl. Madras. 1448, 1828.

This was collected from Walayar, Palghat District. It is seen growing on the understorey trees in evergreen forests. This orchid is very rare and its earlier record in South India is from Palkonda Hills of Andhra Pradesh.

Specimen examined. Kerala State, Palghat District, Walayar, 400 m, 7-iv-1979, Sasidharan 759.

The specimens cited are deposited in the Kerala Forest Research Institute Herbarium.

ACKNOWLEDGEMENTS

We are thankful to Prof. V. P. K. Nambiar, Scientist-in-charge, Botany Division, and Dr. S. Kedarnath, Director, Kerala Forest Research Institute for helpful suggestions and facilities.

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TRICHUR, KERALA,
July 26, 1983.

42. *ISCHAEMUM LACCI* STAPF EX BOR (POACEAE): A NEW ADDITION TO THE FLORA OF INDIA

(*With a text-figure*)

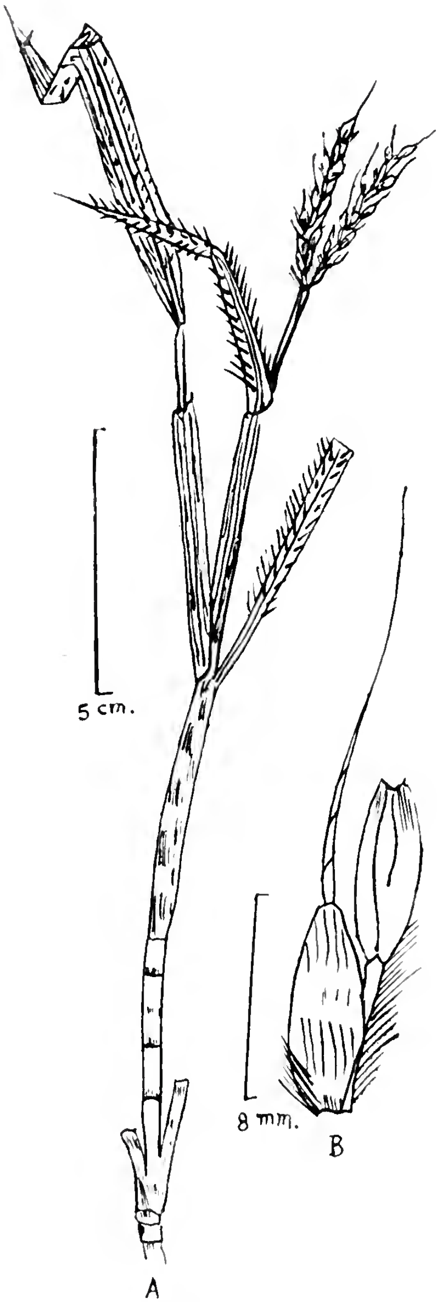

Fig. 1. *Ischaemum lacci* Stapf ex Bor
A. Habit; B. Spikelets.

Ischaemum lacci Stapf *ex* Bor belongs to subfamily Panicoideae, tribe Andropogoneae and subtribe Ischaemineae. This species was described by Bor in Kew Bull. 1950, 187 (1950). This grass has not so far been reported from India. Bor (1960), has mentioned its distribution in Burma, where it seems to be endemic. But collection from Shillong, Khasia, altitude 4000 ft, by J. D. Hooker & T. Thomson (CAL), and Shillong, Barapani, M. P. Guha 43 (CAL) reveals its distribution in India. The present note is intended to provide a description and illustration of this grass.

Ischaemum lacci Stapf *ex* Bor in Kew Bull. 1950: 187 (1950).

Perennial grass, culms upto 120 cm long, erect. Leaves usually 7-17 cm long, 15 cm wide, elliptical, multi-nerved, middle nerve prominent, pubescent at both sides, more in lower surface; ligule 5 mm long, oblong. Racemes 2, 7 cm long. Sessile and pedicelled spikelet jointed, rhachis fragile. Sessile spikelet 8 mm long; lower involucral glume 7-8 mm long, ovate-lanceolate, apex marginate, middle part densely pilose multi-nerved. Upper involucral glume 3-10.5 mm long, lanceolate acute, 3 nerved, minute awned, awn 2.5 mm long. Lower floret male; lemma up to 7 mm long elliptical, hyaline, 3 nerved, acute: stamens 3, anther 2 mm long; palea 5.5 mm long otherwise same as lemma, 2 nerved. Upper floret hermaphrodite; lemma up to 6.5 mm long, bidentate, 3-nerved, awned, awn up to 3 cm long, column 11 mm long; stamens 3, anther 3-3.5 mm long; palea 4.5 mm long, linear lanceolate 2-nerved. Pedicelled spikelet-lower involucral glume 8 mm long, dorsal part pilose, awned. Upper involucral glume 7.5 mm long, upper lemma

similar to sessile spikelet, awned, awn 11 mm long.

Flowering time. November to February.

Distribution. India, Burma.

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Central Botanical Laboratory,
P. O. Botanic Garden,
Howrah 711 103.
August 25, 1983.

ACKNOWLEDGEMENTS

I am grateful to Director, Botanical Survey of India, Howrah, for his encouragement and to Dr. N. C. Majumdar, Ecologist, Botanical Survey of India, for suggestions.

P. R. SUR

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43. *GYMNOPTERIS DELAVAYI* (BAK.) UND. — A NEW FERN RECORD FOR INDIA

During a study of herbarium specimens in CAL herbarium, we came across a specimen collected by Mr. Gour Maity, from Kutty valley, Pittargarh District, Uttar Pradesh. The specimen *Gymnopteris delavayi* (Bak.) Und. which was described by Baker from Yunan, China. The specimen is exactly identical with authentic materials from China, kept in CAL herbarium. This is a new report for India. Description of the species is provided here.

Gymnopteris delavayi (Bak.) Und. Bull. Torry Bot. Cl. 29: 627, 1902; C. Chr. Ind. 341, 1906.

Basinym: *Gumnogramme delavayi* Bak. Ann. Bot. 5: 484. 1891.

Synonym: *Neurogramme delavayi* (Bak.) Diels, Npfl. 262. 1899.

Rhizome short creeping, densely covered with long linear, ferruginous scales. Fronds oblong-lanceolate, simply pinnate, 10-15 cm long, stipe tufted, wiry, castaneous, pilose, 4-5 cm long, pinnae oblong, 5 mm to 1.5 cm long, 5 mm broad, upper surface nearly glabrous, greenish, lower surface densely covered with ovate-lanceolate brown membranaceous scales, apex of scale acuminate, margin of scale entire. Lower pinnae lobed on both sides, sorus covered under the scale, exindusiate.

Specimen examined. Garbyang, ± 3110 m, near Garbyan village, Kutty valley, Pittargarh district, Uttar Pradesh, October 8, 1976. *Gour Maity* 611 (CAL).

It grows on exposed rocks.

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P. O. Botanic Garden,
Howrah 711 103,
September 9, 1983.

S. R. GHOSH
R. K. GHOSH

44. SEASONAL SUCCESSION IN CHLOROPHYCEAE IN LAKHOTIA LAKE

(*With two plates*)

Ecological succession is very common in sand dunes, grasslands, forests, marine shores and other sites. In aquatic ecosystem particularly in fresh waters it is rare among primary producers. Although a number of attempts have been made to study the seasonal variation of the phytoplankton in Indian fresh waters yet little attention has been given to the analysis of seasonal succession. The present study carried out from March, 1977 to February, 1978, is an attempt to observe the seasonal succession of phytoplankton specially among the members of Chlorophyceae, in a tropical lake of western Rajasthan. The state has three seasons, namely summer (March to June), monsoon (July to October) and winter (November to February).

Lakhotia lake is a man-made, rain fed, perennial lake of Pali. It is roughly triangular, having a maximum length of 1823 m in the east-west direction and a breadth of 950 m in the north-south direction. During the present study the maximum depth of the lake was 4.5 m. The vegetation around the vicinity of the lake consisting of xerophytic shrubs and trees, is confined mainly to the southern side. In the littoral zone an aquatic grass *Scirpus tuberosus* grows on the eastern bank. The lake is rich in phytoplankton population and colour of the water is yellowish green due to muddy nature of the bed.

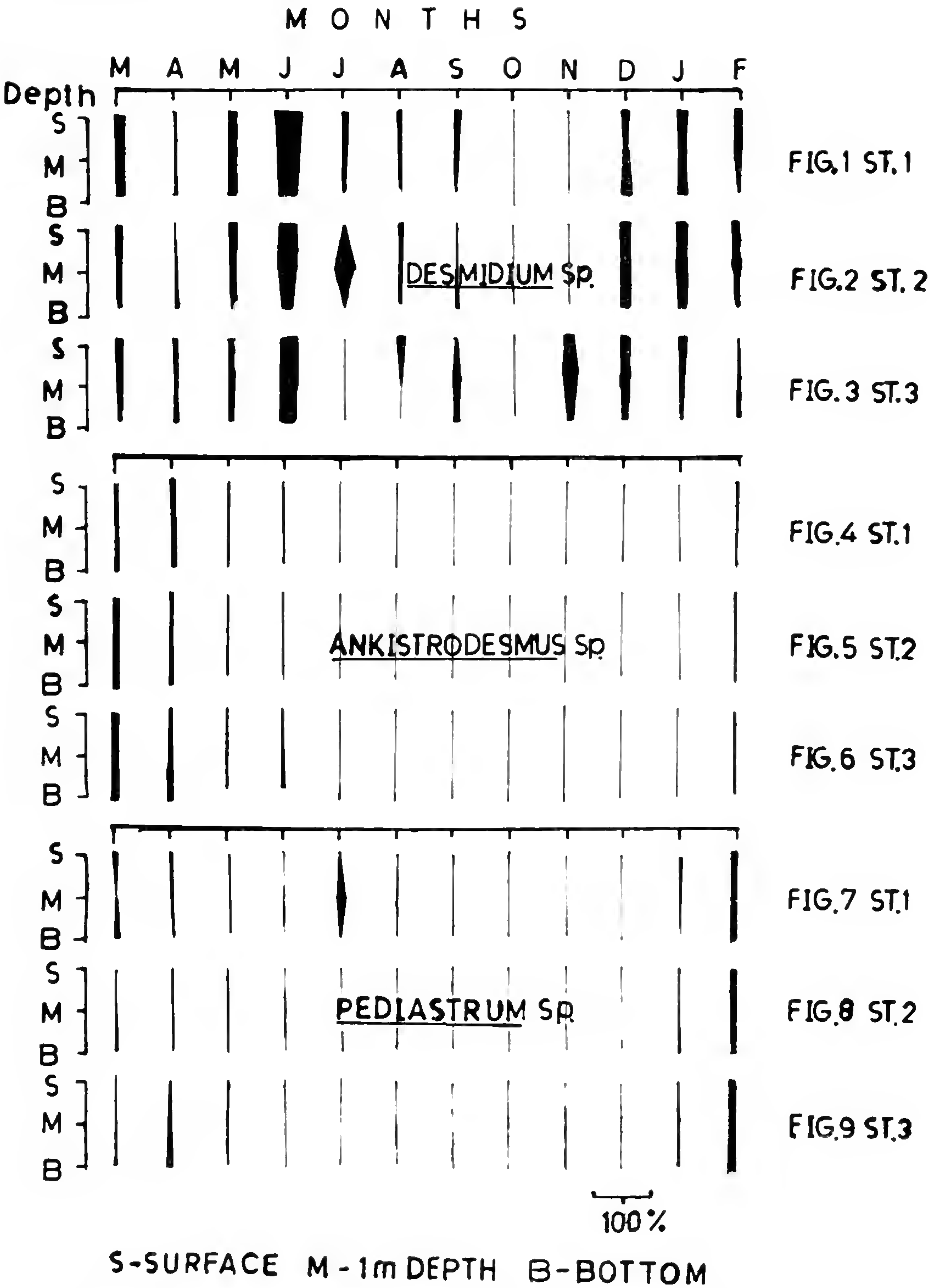
For phytoplankton analysis water samples were collected from three stations (St. 1, 2 and 3) and three depths (surface, 1 m and bottom) to get a complete picture of variation in population along vertical as well as horizontal profile of the lake. Phytoplankton were counted by sedimentation method, after fixing in Lugol's Iodine solution and preserving in 3% formalin. Identification was done up to generic level.

Phytoplankton population comprised of cyanophyceae, chlorophyceae, basillariophyceae and dinophyceae. In chlorophyceae fifteen genera were identified out of which seasonal succession was shown by *Desmidium* sp., *Pediastrum* sp., *Ankistrodesmus* sp. and *Closterium* sp., *Mougeotia* sp. and *Volvox* sp. seasonal variation of above mentioned genera are shown in plates 1 and 2, figures 1-9. The population had been given in percentages calculated in respect to total phytoplankton count.

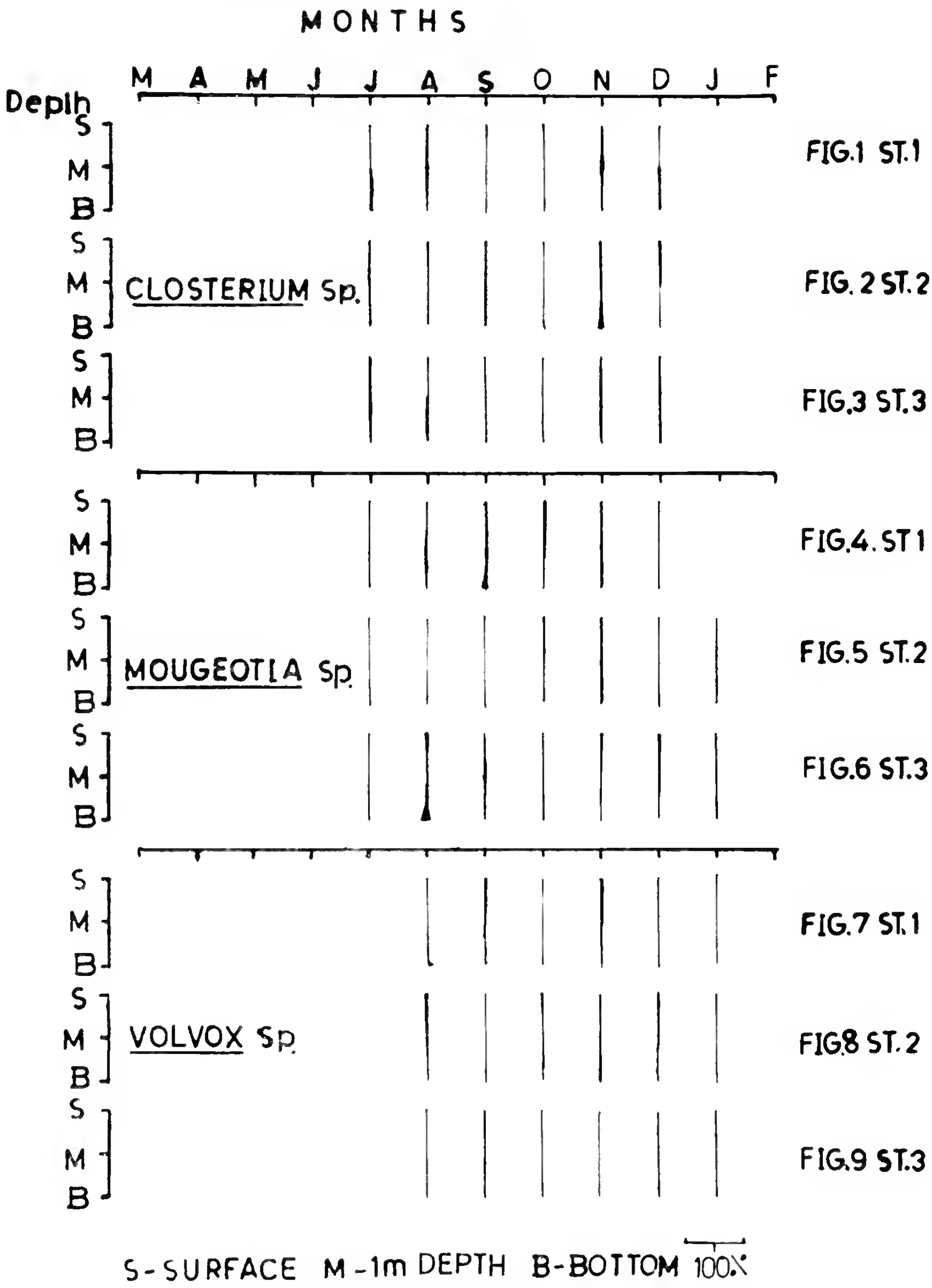
Desmidium sp. was most dominating genus among the members of Chlorophyceae. Its population started increasing in April, attaining its peak at the end of summer (June). The percentage ranged (Sts. 1-3) from nil to 47.10 at the surface, nil to 37.39 at 1 m depth and nil to 34.72 at the bottom (Plate 1, Figs. 1-3).

Ankistrodesmus sp. showed erratic distribution, appearing at all the stations and depths during March, June and February only. The maximum and minimum populations were recorded in February and May respectively. Its percentage fluctuated (Sts. 1-3) from nil to 4.76 at the surface, nil to 7.84 at 1 m and nil to 8.70 at the bottom (Plate 1, Figs. 4-6).

Pediastrum sp. was present throughout the summer months, with maximum population in early summer (March). Later it appeared



Seasonal succession among members of Chlorophyceae in Lakhotia lake.



Seasonal succession among members of Chlorophyceae in Lakhotia lake.

occasionally and was recorded during following monsoon and winter months at most of the depths and stations. The percentage composition ranged (Sts. 1-3) from nil to 5.88 at the surface and 1 m depth and nil to 6.17 at the bottom (Plate 1, Figs. 7-9).

Closterium sp. appeared in monsoon (July) at all the stations, after attaining maximum population in November it disappeared in January. Its percentage varied (Sts. 1-3) from nil to 4.26 at the surface, nil to 4.84 at 1 m and nil to 7.69 at the bottom (Plate 2, Figs. 1-3).

Mougeotia sp. like *Closterium* sp. appeared in July and was present at the bottom at stations 1 and 2 up to January. In February it disappeared. The population varied (Sts. 1-3) from nil to 6.45 at the surface, nil to 5.52 at 1 m depth and nil to 10.58 at the bottom (Plate 2, Figs. 4-6).

Volvox sp. made its appearance in monsoon (August) and after attaining its peak in November the population declined in the following months and totally disappeared in February. Population varied (Sts. 1-3) from nil to 7.58 at the surface, nil to 4.02 at 1 m and nil to 9.23 at the bottom (Plate 2, Figs. 7-9).

The results clearly indicate that the succession among members of Chlorophyceae varies from season to season in Lakhotia lake. *Desmidium* sp., *Pediastrum* sp. and *Ankistrodesmus* sp. flourished during summer season. At the onset of monsoon their population declined and they were succeeded in the following months by *Closterium* sp., *Mougeotia* sp. and *Volvox* sp. The latter genera flourished during monsoon and early winter months when the former genera were either absent or their population was insignificant. Towards the end of winter due to the reappearance and increase in the population of *Desmidium* sp., *Pediastrum* sp. and *Ankistrodesmus* sp. *Closterium* sp., *Mougeotia* sp. and *Volvox* sp. totally disappeared. Thus it was observed that in Lakhotia lake such a type of seasonal succession hampers the blooming of any genera which leads to the eutrophic condition. The physical and chemical factors responsible for the seasonal succession in fresh water bodies are unknown. Therefore, an intensive study is required for ascertaining the role of various parameters responsible for the seasonal succession of phytoplankton.

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ERRATA

VOLUME 81, NO. 2: AUGUST 1984

Misc. Note No. 24. A note on species named *Lycaena pavana* (Lepidoptera: Lycaenidae)

On page 493,

Right side column,

Line 2, For Kollar (1948: 416) read Kollar (1848: 416)

Misc. Note No. 25. Correct name of the Red-base Jezebel butterfly (Lepidoptera: Pieridae)

On page 495,

Left side column,

Line 7 — For *aglaid*, read *aglaia*
Line 13 — For *agalaja*, read *aglaja*
Line 14 — For *aglaja*, read *aglaia*

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1985 August | Vol. 82 | No. 2

FEMALE EMIGRATION IN *PRESBYTIS JOHNII*: A LIFE-HISTORY STRATEGY[1]

RAUF ALI,[2] J. M. JOHNSON[3] AND JIM MOORE[4]

Between 1976 and 1981 a number of female Nilgiri langurs (*Presbytis johnii*) were observed associating with other primate species or with nonbreeding conspecifics in dry deciduous forest at Mundanthurai, Tamil Nadu (India). Such associations have not been reported for this species where it occurs in neighbouring evergreen forests. These observations, combined with census data showing a male-biased sex ratio in the deciduous forest (indicative of suboptimal habitat), suggest that female inter-group transfer in this species represents a search for high-quality habitat. Unlike many social primates, females of this species evidently place greater emphasis on territory quality than on genetic relationships when deciding where to live and whom to live with.

Female emigration has now been documented for a number of primate species including bonnet macaques (Ali 1981), chimpanzees (Pusey 1980), gorillas (Harcourt *et al.* 1976), howler monkeys (Rudran 1979), purple-faced langurs (Rudran 1973), and red colobus (Struhsaker & Leland 1979, see Moore 1984 for review). Four explanations have been proposed for this phenomenon: (1) avoidance of inbreeding (Pusey 1980), (2) attempts to avoid infanticidal males (Marsh 1979), (3) an adaptive response to ecological changes in a patchy environment (Marsh 1979), and feeding competition leading to active expulsion from the group (Jones 1980).

In this paper we summarize observations made at different times since 1976 on instances of female emigration among Nilgiri langurs at the Mundanthurai Sanctuary in Tamil

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Nadu, India. The bulk of these observations were made on the Mundanthurai Plateau, in lowland dry deciduous forest. Nilgiri langurs (*Presbytis johnii*) occur at lower densities here than in their normal highland (above 600 m) evergreen forest habitat: approximately 1.4 groups/km^2 as opposed to 4 groups/km^2 in evergreen forests (Oates 1979). Group sizes are also much smaller, being, on average, 6-8 animals in each bisexual group compared to the normal 18-20 animals/group in evergreen forest. The habitat in which they were observed is at the edge of their range and there is an area of partial sympatry with the Hanuman langur (*Presbytis entellus*) in this area. Group social structure is characterized by the existence of the typical langur uni-male group as well as all-male bands (*cf.* Hrdy 1977); in the evergreen forest, all-male bands were not seen and males outside bisexual groups were solitary (Ali, *unpublished observations*).

A striking feature of observations on Nilgiri langurs in this area was the unusual places in which juvenile and subadult females were observed. The first observation, in Nov. 1976, was of a large juvenile in association with a multi-male bisexual troop of Hanuman langurs. The same individual was present with the Hanuman langur troop 4 years later, in Dec. 1980, and was seen interacting normally with her troopmates. She changed groups in January 1981 to a neighbouring *P. entellus* troop.

A second large juvenile was observed at the same time associating with a group of bonnet macaques in semi-evergreen forest approximately 30 km from the first site. This association lasted from January until May, 1977. Yet another observation of a single subadult female Nilgiri langur with a group of Hanuman langurs was made in a lowland area at Nambikoil, near Kalakad, further south in the hill range (see also Johnson 1982). In addition, juvenile and subadult females regularly join male bands to form 'predominantly male groups' similar to those reported for *P. senex* by Rudran (1973) and Manley (1978). Juvenile Nilgiri langur females travelling alone or in pairs were first reported by McCann (1932).

Further observations were made on Nilgiri langur groups in this area in December 1980 which revealed the following breakdown in group compositions. There were 8 groups in the area. Of these, 2 were all-male and one was 'predominantly male'. This consisted of 3 adult males and 2 subadult females. The remaining five groups were bisexual. Reasonably accurate group counts were possible for 6 of the groups and these are given in Table 1.

TABLE 1

P. johnii CENSUS AT MUNDANTHURAI (LOWLAND DRY DECIDUOUS FOREST), 1980

No.	Type	AM	AF	SF	I	Total
1	All-male	5				5
2	All-male	3				3
3	Pred-male	3		2		5
4	Bisexual	1	4		2	7
5	Bisexual	1	2	1	1	5
6	Bisexual	1	4		(3)	8
	Total	14	10	3	6	33

(AM = adult male; AF = adult female; SF = subadult female; I = infant)

Earlier census results from Kodamadi, about 9 km upstream from Mundanthurai, in moist deciduous forest on the fringe of the langur's evergreen forest habitat, yield an interesting comparison. Three groups censused there gave a total count of 5 males and 10 females. Although this is not significantly different

from the lowland sex ratio (X^2 = 1.42 with 1 df; NS), the relative predominance of males in the suboptimal habitat agrees with findings for *P. entellus* at Dharwar (Sugiyama *et al.* 1965) and at Mt. Abu (Moore, in preparation). For the larger sample at Mt. Abu, a similar comparison of overall adult sex ratios for 22 groups divided between "optimal" and "suboptimal" habitats shows a highly significant skew (X^2 = 25.38 with 1 df; $p << .001$; N = 178).

Discussion

The salient factors that emerge are as follows:

a) The data given here suggest that females disperse from their natal groups in the deciduous zone.
b) There is as yet no record of female emigration in the evergreen zone, though this might well occur.
c) Male emigration has been documented both in the evergreen zone and in the deciduous zone.
d) Sex ratios show excess males in the deciduous zone, and excess females in the evergreen zone.
e) The presence of all-male bands appears to indicate that the deciduous habitat is suboptimal.

This brings us to the reasons why the emigration pattern described above occurs. Since nulliparous subadult females emigrate, infanticide avoidance can be ruled out. Inbreeding avoidance can also be excluded, since males transfer as a matter of course (Moore & Ali 1984). These observations are consistent with hypothesis (3), that females migrate to increase their access to resources, moving from a suboptimal to an optimal habitat.

The possibility of limited female emigration within the evergreen zone cannot be ruled out at this stage. The difficulties of recognizing individuals in the dense forest habitat make this possibility difficult to test.

It must be pointed out that the phenomena described above are, essentially, transient phenomena. It is hardly likely that a female might stay forever in a predominantly male group, given the observations so far on the uni-male structure of the Nilgiri langur's breeding groups. Long-term associations with other species would also result in reduced reproductive success. The phenomenon can best be described as "hitchhiking" — in this sense, gaining an advantage out of a temporary association, rather than remaining solitary. It is not clear, however, whether the next stage would be to join a unimale group or to splinter off with one of the members of the predominantly male group to form the nucleus of a new unimale group. It is possible of course that both happen. There are interesting possibilities for future research in this area.

Acknowledgements

Dr. Warren Brockelman commented critically on an earlier draft. R. A.'s field study was funded by NIMH grant 24269 to Steven Green. He would like to thank the Tamil Nadu Forest Dept. for permission and facilities to work at Mundanthurai. J. M.'s work was funded by NSF grant BNS-7923014 and by BNS-7908267 to D. B. Hrdy. He would like to thank S. B. and D. B. Hrdy, S. M. Mohnot, the Rajasthan Forest Dept. and the Government of India for encouragement and for allowing him to study Indian langurs.

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FECUNDITY OF THE GARHWAL HIMALAYAN MAHSEER *TOR PUTITORA* (HAM.)[1]

PRAKASH NAUTIYAL AND M. S. LAL[2]

This paper describes studies on the fecundity of the Garhwal Himalayan mahseer *Tor putitora* procured from the river Nayar. Both gravimetric and volumetric methods were used to determine the average fecundity. It ranged from 26,997.71 to 98,583.5 in total length range of 780.0-1377 mm. Linear relationship existed between log fecundity and log ovary length, weight and volume as well as with log fish length and weight. Comparative fecundity ranged from 3.374 to 8.943.

INTRODUCTION

Reproduction provides the replenishment so essential for the preservation of the species and its abundance. The reproduction capacity is an adaptation which ensures the survival of the species under the conditions in which it originated and exists. It has been defined as the mean number of ripening eggs per brood prior to the next spawning period. Studies on fecundity are essential from the viewpoint of production, stock management and assessment in any water body. Considerable work has been done on the fecundity of the fishes in India as well as abroad (Kesteven 1942, Khan 1939, Simpson 1951, 1959a & b, Lehman 1953, Pillay 1954, Alikunhi 1956, Bagenal 1957, 1978, Sarojini 1957, Das 1964, 1967, Verghese 1973, 1976, Chondar 1977, and Natrajan and Reddy 1980).

The fecundity of mahseers has been studied by Desai 1973, Chaturvedi 1976 and Pathani 1981. However, there is no literature pertaining to the same on the Garhwal Himalayan mahseer.

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MATERIALS AND METHODS

Mahseer was procured regularly for two years from the river Nayar during the spawning season by angling or gill netting in the vicinity of Banghat, an important fish landing centre on this river. Length and weight of the fish and ovary was recorded in fresh condition. They were then dissected out and fixed in 10% formalin.

After allowing the ovaries to attain hardness they were taken out and dehydrated using cotton or blotting paper. This weight and volume of each ovary was recorded. Three samples from the anterior, middle and posterior section were mixed and centrifuged for homogeneity. In fact there was no discrimination in ova-diameter frequency in different parts of the ovary. The subsample of the homogenised mass was subjected to volumetric (Kandler & Pirwitz 1957) and gravimetric counts (Wet method — McGregor 1922 and Dry method — Simpson 1959a). The average of all these methods was recorded as mean fecundity. Comparative fecundity was calculated as the ratio of total number of ova and total weight of fish (Das 1964). Relationships between fecundity and fish, and ovary weights and lengths (log), were determined by Least Squares method, i.e. $Y = a + bx$.

Observations

The fecundity varied from 26,997.71 to 98,583.5 in the weight range of 3,500-23,000 gm (table 1). The average comparative fecundity was calculated to be 6.13.

Various relationships such as log fecundity — fish length and weight and log fecundity — ovary length, weight and volume, were established to be linear (table 2). It is noteworthy that fecundity bears a closer relationship to weight and volume, especially that of the ovary as compared to the length.

Discussion

The fecundity of *Tor tor* varies from 6,667-43,610 in the size range of 290-750 mm according to Karamchandani *et al.* (1967) and from 7,000-1,01,600 in the fishes ranging

Table 1

Fecundity estimates of *Tor putitora* as assessed by various methods

Length of fish (mm)	Weight of fish (gm)	Fecundity Estimation: Volumetric method	Gravimetric method	Wet method	Average fecundity	Comparative Fecundity
780.00	3500.00	26697.5	27541.5	27938.93	27392.60	7.03
786.00	4000.00	35636.4	36800.0	34894.88	35777.09	8.94
823.00	5000.00	33635.0	34860.0	33334.98	33943.32	6.78
960.00	9000.00	56000.0	56990.0	56000.00	56330.00	6.25
1000.00	6000.40	29800.0	29300.0	29800.00	29633.33	4.93
1080.00	8000.00	28055.0	27081.0	25857.14	26997.71	3.37
1377.00	23,000.00	95865.0	93280.0	106605.50	98583.50	4.82

Table 2

Regression data and analysis of variance for linearity of various relationships

Relationships between Fecundity and --	Correlation Coefficient (r)	Variance ratio: Observed 'F'	5% F	Regression Equation
Total fish length (L)	0.67008	5320.6362*	6.61	Log. F = 1.5152 + 1.5561 Log L.
Total fish weight (W)	0.84418	8689.7887*	6.61	= 0.63177 + 2.1731 logW
Ovary length (l)	0.81956	1660.8331*	6.61	= 1.5048 + 2.0463 log l
Ovary weight (w)	0.86422	3851.304*	6.61	= 0.87117 + 2.6666 log w
Ovary volume (v)	0.86550	1718.583*	6.61	= 0.82669 + 2.8032 log v

* Significant

between 283-750 mm by Desai (1973). Recently, a *Tor khudree* measuring 630 mm and weighing 3.6 Kg, was reported to possess 20,000 eggs (Kulkarni & Ogale 1978) while fecundity estimates of *Tor putitora* from Kumaon Lakes revealed that the fish measuring 33.9-51.7 cm in length possessed 7,076-18,525 eggs (Pathani 1981). The Garhwal Himalayan mahseer, if compared to these estimates can certainly be considered to be equally productive, for the average fecundity ranged between 26,997.71-98,583.5. However, when compared to fishes like *Labeo bata,* it can be categorised as having low fecundity, for in the latter, the size range of 441-544 mm, according to Bhatnagar (1964) was able to produce 3,01,861-5,76,251 eggs, and fishes measuring 280-480 mm in length, according to Joshi & Khanna (1980) have fecundity range of 45,910-3,99,050.

Das (1964) propounded the concept of comparative fecundity (CF) for evaluating the actual breeding powers of the fishes and considered *Mystus bleekeri* with an average fecundity of 15,962 to be a 'prolific breeder', value of CF being 7.03 as compared to 6.13 of *Tor putitora.* Obviously, the latter is a 'poor breeder'.

The food consumed by the fish, especially the parent population, determines not only the fecundity but also the quality of the sexual products and the viability of the offspring (Nikolaev 1958, Nikolskii 1961a & b), thus emphasizing the fish-food relationship, which Ber (1854) saw to be a complex one. Scott (1962) reported that the lowering of fecundity is intensified by poor food intake which seems to stand true in case of the Garhwal Himalayan mahseer for there probably exists scarcity of 'basic' food, i.e. insects, especially in case of the Ganga near the foot hills of the Garhwal region. This probability is based on the fact that the tributaries Alaknanda and Nayar, especially the former which is one of the main tributaries, possessed poor quantities of the heterotrophic population (Nautiyal & Lal 1978).

Fecundity was considered to vary as a square of the fish length (Franz 1910a & b, Keisselevitch 1923, Clark 1934). Later on Simpson (1951) reported egg production to be an internal phenomenon associated with the manner in which the germinal epithelium is folded so as to fill the volume of the ovary thus relating it to the ovary volume and therefore to the cube of the length. As in the present case, a linear relationship between fecundity — length and weight of the fish and ovary, have been established by several authors (Kesteven 1942, Lehman 1952, Bagenal 1957, Sarojini 1957, 1958, Pillay 1958, Verghese 1961, 1973, 1980, Desai 1973, Joshi and Khanna 1980 and Pathani 1981).

The interesting feature of the present study was a closer relationship of fecundity to fish weight as compared to its length as also reported by Smith (1947) and Spanovskaya *et al.* (1963).

It is apparent from the above discussion that the Garhwal Himalayan mahseer is a 'poor breeder' and that breeding in the natural environment is surely a handicap for the mahseer to flourish.

Acknowledgements

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A CONTRIBUTION TO THE FLORA OF DODITAL — A HIGH ALTITUDE LAKE IN THE GARHWAL HIMALAYA (UTTARKASHI), U.P.[1]

K. S. Negi, J. K. Tiwari and R. D. Gaur[2]

(*With two plates*)

The present communication is an account of Angiosperms collected from a high altitude lake (Dodital) in Garhwal Himalaya during the year 1982. Dodital is situated on way to Gangotri, a famous pilgrim place. It lies between 30° 47′ 15″ N latitudes and 78° 29′ 40″ E longitudes. The dominant families of this zone are Ranunculaceae, Rosaceae, Saxifragaceae, Asteraceae, Primulaceae, Lamiaceae, Polygonaceae, Orchidaceae and Poaceae. The paper enumerates a list of 275 species and 150 genera, represented by 60 families.

Introduction

The Himalayas, inspite of being the toughest to approach, have been receiving the attention of plant explorers since time immemorial. Thomas Hardwicke (1757-1835) was the first European to collect the plants from North-Western Himalaya, including the Alaknanda valley. William Spencer Webb, Hyder Jung Hearsay and Felix Vincent Raper, who were the members of an expedition, organised during 1802-1803, collected plants from Gangotri and Yamunotri areas (*see* Burkill 1965). Strachey and Winterbottom made extensive collections from Garhwal, Kumaon and adjacent parts of Tibet from 1846-1849 (*see* Duthie 1906). Osmaston (1927) published forest flora for Kumaon in which he described the trees, shrubs and climbers of erstwhile Kumaon division including some area of Garhwal. Some other known workers are Ghildyal (1957), Gupta (1956, 1957, 1962), Rao (1959, 1960), Naithani (1967), Bhattacharyya and Malhotra (1982), Dey *et al.* (1968), Semwal and Gaur (1981), Kala and Gaur (1982). However, this part of the Himalaya which embodies a high altitude lake, associated with temperate as well as alpine vegetational features, has not been covered by the earlier workers. Therefore, it was thought desirable to study the flora of Dodital. It is worthwhile to note that this lake is one of the important scenic sites, visited by a number of tourists during the favourable period. The vegetational features enumerated in the following text, have special importance to the tourists and the conservation ecologists.

Geography and Climate

Dodital is situated on way to Gangotri, in Uttarkashi district, 32 Km. away from the main township, Uttarkashi (Plate 1). This lake is located at an elevation of 3004 m a.s.l. and lies in between 30° 47′ 15″ N latitude and 78° 29′ 40″ E longitude. The lake is surrounded by precipitous lofty mountains and glaciers. Several pretty falls and hill streams

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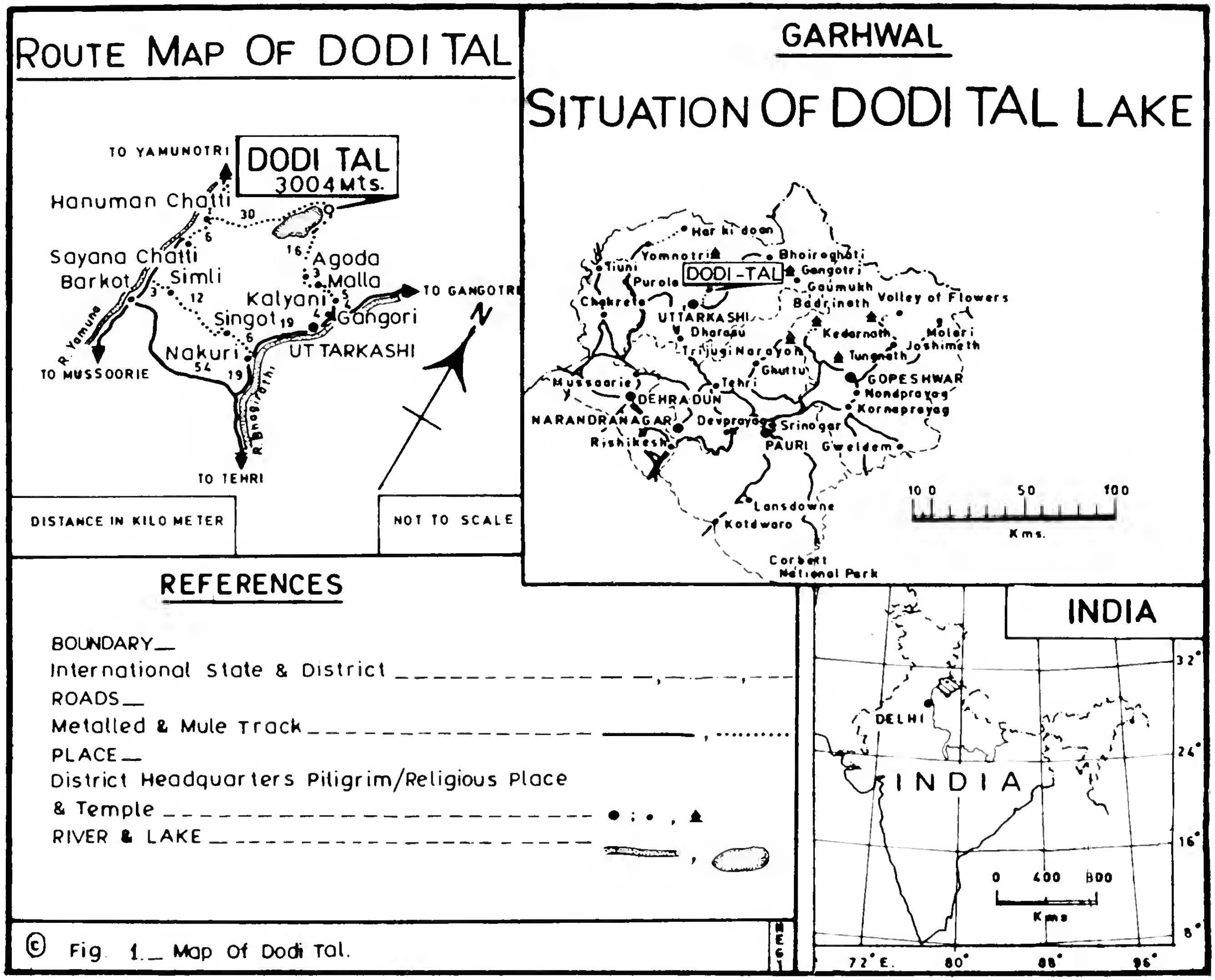
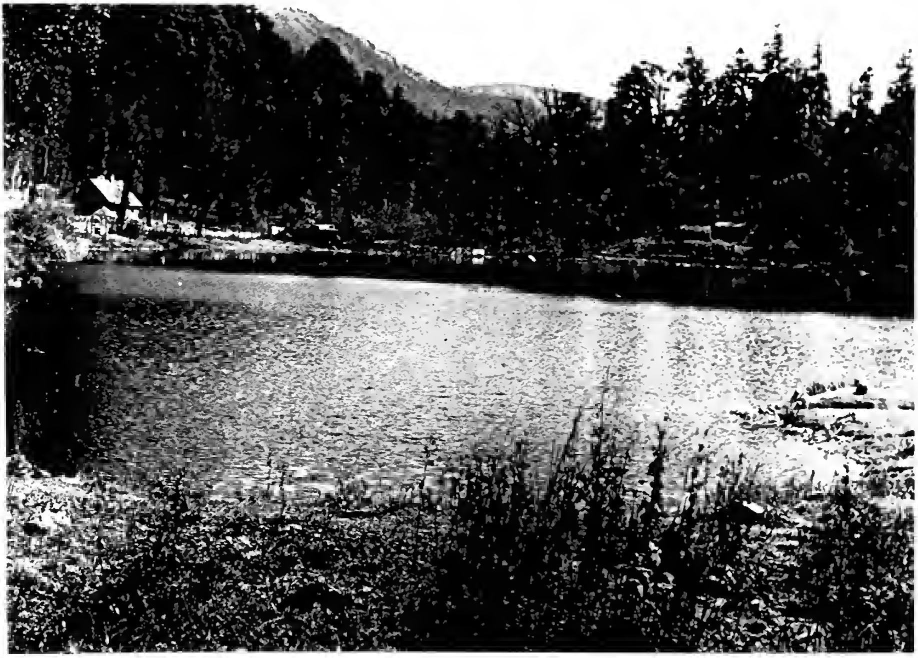
PLATE I



Map of Dodital.



Above : View of lake Dodital.

Below : Last inhabited village, Agora enroute to Dodital.

add to the charm of the valley. The approach of the lake begins from Gangori, a place situated at a distance of 4 Km from Uttarkashi town. The route leads through Kalyani and Agora. Agora, enroute Dodital, is the last inhabited village (Plate 2). It follows a 16 km spectacular hill route through dense forest to reach the lake proper. The lake is situated at the timber line zone, which constitutes the vegetation of temperate as well as of alpine zone. Higher up to the lake, there are steep mountainous slopes with alpine vegetation.

The principal climatic factors influencing the mountainous zone, are high rain fall, high relative humidity and low temperature. Upper mountainous limits of the area are covered with snow for nearly 9-10 months in a year.

VEGETATION AND FLORISTIC COMPOSITION

The vegetation of Dodital is characterised by a comparatively lush flora, represented by temperate and high altitudinal himalayan plants. The area may be divided into three sections, comprising of the aquatic zone or the lake proper (approximately 200 x 150 m), encircling marshy zone and the outer most mountainous slope covered by thick vegetation.

The route on way to this high altitude lake, crosses areas having almost all diversities of high altitude vegetation and floristic composition rarely met with in other areas of the Garhwal Himalaya. *Abies pindrow, Acer caesium, Betula utilis, Quercus himalayana, Q. semecarpifolia* associated with *Rhododendron arboreum* make the tree limit on the route. Undergrowth in the Rhododendron forest is rather poor and the few notable plants are represented by *Cirsium involucratus, Goodyera repens, Habenaria ensifolia, Hemiphragma heterophyllum, Primula edgeworthii* and *Rubus niveus.* The area presents a panoramic view of the thick forest of *Pinus excelsa, Abies pindrow* occurs on drier slopes. A mule track goes down through a thin forest of *Quercus himalayana, Rhododendron arboreum* mixed with *Alnus nepalensis, Cotoneaster affinis* var. *bacillaris, Lyonia ovalifolia, Viburnum cotinifolium* and common temperate herbs like *Anaphalis busua, A. contorta, Elsholtzia polystachya, E. strobilifera* and several others. It offers an interesting assemblage of temperate species and a good number of epiphytes. Some of the fine herbaceous members are *Corydalis cornuta, C. cashmeriana, Desmodium tiliaefolium, Elsholtzia cristata, Geranium wallichianum, Polygonum polystachyum, Sedum trifedum, Swertia cordata, Cirsium involucratus, Solidago virga-aurea, Valeriana hardwickii* and many others. While approaching the lake vegetation becomes dense with more shrubby members dominated by *Berberis chitria, Cotoneaster microphylla, Indigofera heterantha, Salix elegans* and *Viburnum foetens.*

The area near the lake is occupied mostly by the species of *Salix, Caltha palustris, Potentilla fulgens, P. fruticosa, Androsace rotundifolium, Pedicularis hoffmeisteri.* The slopes hold growths of *Polygonum polystachyum, Impatiens brachycentra, Cirsium involucratus,* and *Parnarsia nubicola.* There is a rich herbaceous growth comprising of *Polygonum alpinum, Thalictrum* sp., *Senecio nudicaulis, Swertia cordata, Oxyria digyna, Taraxacum officinale* met in moist places. At higher elevations white flowered *Sedum linerifolium* and yellow flowered *Potentilla atrosanguinea* are quite common. Surrounding mountains in the neighbourhood of the lake support a thick forest of *Quercus semecarpifolia, Acer caesium, Salix elegans, Rhododendron campanulatum, Taxus baccata* with a rich assemblage of climbing shrubs as well as temperate herbs and shrubs.

Darwa top is at the edge of a precipitous rock and the surrounding panorama reveals a

pictorial view of the snow clad mountains and glaciers in the back ground and the vast extension of the 'Bandarpuchh' with large widening course disappearing with the great wilderness of the snowy heights. On the Darwa top are beautiful reddish carpets of *Polygonum* sp., *Cassiope fastigiata, Rhododendron anthopogon, Cotoneaster falconerii.* The dry and shady rocks and slopes hold mainly *Bergenia stracheyi, Meconopsis aculeata, Syringa emodi* and *Potentilla atrosanguinea.*

Enumeration of species

This work is primarily a record of high altitude plants collected from Dodital and its vicinity during the year 1982, with short field notes. In this work Bentham and Hooker's system of classification has been followed with some modifications as suggested by Hutchinson (1973). As far as possible recent names of plants have been followed. Botanical names and localities with altitude have been mentioned. Field number of each specimen follows the month and year in the list and the specimens are preserved in the Herbarium of Botany Department, Garhwal University, Srinagar (GUH).

DICOTYLEDONS

Ranunculaceae

Anemone rivularis Buch.-Ham. ex DC.

Branched silky pubescent herb with white flowers. 3000 m, June 1982, 2693.

A. obtusiloba D. Don

Herb with white flowers. 3200 m, June 1982, 2700.

Caltha palustris Linn.

Herb with yellow flowers. 3000 m, May 1982, 2695.

Clematis buchaniana DC.

Climbing shrub with creamy white flowers. 2500 m, May 1982, 627.

C. montana Buch.-Ham. ex DC.

Climbing shrub with white or tinged with pink flowers. 2500 m, June 1982, 1023.

Delphinium denudatum Wall. ex Hook. f.

Herb with deep blue flowers. 2700 m, May 1982, 1947.

Ranunculus diffusus DC.

Hairy herb with yellow flowers. 2800 m, June 1982, 1095.

R. laetus Wall. ex Royle

Herb with yellow flowers. 2700 m, June 1982, 1577.

Thalictrum foliolosum DC.

Herb with white flowers. 2800 m, June 1982, 1653.

T. javanicum Bl.

Herb with white flowers. 3000 m, June 1982, 817.

Berberidaceae

Berberis asiatica Roxb. ex DC.

Shrub with yellow flowers. 2700 m, May 1982, 616.

B. chitria Lindl.

Shrub with yellow flowers. 2700 m, May 1982, 617.

B. lycium Royle

Shrub with yellow flowers. 2500 m, May 1982, 618.

Papaveraceae

Papaver dubium Linn. var. **glabrum** (Royle) Koch.

Glabrous herb with red flowers. 2400 m, May 1982, 1683.

Meconopsis aculeata Royle

Prickly herb with blue flowers. 3200 m, June 1982, 2816.

Fumariaceae

Corydalis cashmeriana Royle
Delicate herb with blue flowers. 3100 m, May 1982, 772.

C. cornuta Royle
Branched herb with yellow flowers. 3000 m, June 1982, 870.

Fumaria indica (Haussk.) Pugsley
Herb with rose and deep purple tipped flowers. 2500 m, May 1982, 3813.

Brassicaceae

Arabidopsis thaliana (Linn.) Heyn.
Herb with white flowers. 2700 m, May 1982, 1845.

Cardamine scutata Thunb.
Glabrous herb with white flowers. 3000 m, June 1982, 1724.

Violaceae

Viola biflora Linn.
Glabrous herb with yellow flowers. 2500 m, June 1982,, 2708.

Caryophyllaceae

Arenaria serpyllifolia Linn.
Herb with white flowers. 2800 m, June 1982, 1590.

Stellaria paniculata Edgew.
Herb with white flowers. 2800 m, June 1982, 741.

S. latifolia Benth.
Herb with white flowers. 2500 m, June 1982, 812.

Hypericaceae

Hypericum elodeoides Choisy
Herb with yellow flowers. 2500 m, May 1982, 1744.

H. perforatum Linn.
Herb with yellow flowers. 2500 m, June 1982, 841.

Malvaceae

Malva verticillata Linn.
Herb with white-blue flowers. 3100 m, June 1982, 4782.

Geraniaceae

Geranium nepalense Sweet
Soft hairy herb with dark purple flowers. 2500 m, June 1982, 853.

G. wallichianum D. Don
Hairy herb with pinkish purple flowers. 3000 m, June 1982, 667.

Balsaminaceae

Impatiens brachycentra Kar. & Kir.
Herb with white flowers. 3200 m, June 1982, 2669.

I. cristata Wall.
Herb with yellow flowers. 2700 m, May 1982, 3253.

I. scabrida DC.
Herb with yellow flowers. 2500 m, June 1982, 1103.

Rutaceae

Boenninghausenia albiflora (Hook.) Reichb.
Herb with white flowers. 2700 m, May 1982, 623.

Skimmia laureola Sieb. & Zucc.
Glabrous aromatic shrub with yellow flowers. 3000 m, May 1982, 1064.

Aquifoliaceae

Ilex dipyrena Wall.
Tree with greenish yellow flowers. 2800 m, April 1982, 4743.

CELASTRACEAE

Euonymus tingens Wall.
Tree with yellow flowers. 2700 m, May 1982, 4730.

RHAMNACEAE

Rhamnus virgatus Roxb.
Shrub with greenish flowers. 2700 m, April 1982, 5157.

VITACEAE

Ampelocissus divaricata (Wall. ex Lawson) Planch.
Climbing shrub with red flowers. 2700 m, April 1982, 4783.

Tetrastigma serrulatum (Roxb.) Planch.
Climbing shrub with yellowish flowers. 2500 m, June 1982, 4784.

ACERACEAE

Acer caesium Wall.
Tree with yellow green flowers. 3000 m, April 1982, 1730.

A. lavigatum Wall.
Tree with white flowers. 2700 m, April 1982, 4785.

Aesculus indica Colebr. ex Canbess.
Tree with white pinkish flowers. 3000 m, June 1982, 4170.

ANACARDIACEAE

Pistacia integerrima Stewart
Tree with greenish yellow flowers. 2500 m, April 1982, 4184.

Rhus wallichii Hook. f.
Tree with greenish yellow flowers. 2500 m, April 1982, 4786.

FABACEAE

Astragalus himalayanus Klotzsch.
Shrub with yellow flowers. 2800 m, April 1982, 1412.

Desmodium tiliaefolium D. Don
Shrub with pink flowers. 2700 m, June 1982, 1916.

Indigofera heterantha Wall. ex Brand.
Shrub with bluish flowers. 2500 m, June 1982, 976.

Parochetus communis Buch.-Ham. ex D. Don
Hairy herb with blue flowers. 3000 m, April 1982, 2608.

ROSACEAE

Cotoneaster bacillaris Wall. ex Lindl.
Shrub with white flowers. 2500 m, May 1982, 4186.

C. acuminata Lindl.
Shrub with white flowers. 3200 m, May 1982, 2834.

C. microphylla Wall. ex Lindl.
Shrub with white flowers. 3000 m, May 1982, 836.

Fragaria indica Andr.
Herb with white flowers. 2600 m, June 1982, 1109.

F. vesca Linn.
Silky hairy herb with white flowers. 3000 m, June 1982, 981.

Geum elatum Wall.
Herb with bright yellow flowers. 3200 m, June 1982, 2720.

Potentilla atrosanguinea Lodd.
Herb with purple flowers. 3300 m, June 1982, 863.

P. fulgens Wall. ex Hook.
Herb with yellow flowers. 2800 m, April 1982, 720.

P. fruticosa Linn.
Herb with bright yellow flowers. 3300 m, June 1982, 2721.

P. nepalensis Hook.
Hairy herb with dark crimson flowers. 2700 m, June 1982, 865.
Pyracantha crenulata (D. Don) Roem.
Spiny shrub with white flowers. 2500 m, April 1982, 834.
Rosa macrophylla Lindl.
Prickly shrub with pink white flowers. 2900 m, June 1982, 982.
Rubus niveus Wall.
Prickly shrub with pink white flowers. 2500 m, April 1982, 3871.
Spiraea bella Sims.
Shrub with pink flowers. 3200 m, June 1982, 980.
S. canescens D. Don
Shrub with white flowers. 3100 m, June 1982, 981.

Saxifragaceae

Bergenia ciliata (Royle) Raizada
Herb with pink purple flowers. 2800 m, April 1982, 3866.
Deutzia corymbosa R. Br.
Shrub with pink purple flowers. 2700 m, June 1982, 4787.
D. staminea R. Br.
Shrub with white flowers. 2700 m, April 1982, 765.
Parnassia nubicola Wall. ex Wight
Glabrous herb with white flowers. 3000 m, April 1982, 2621.
Saxifraga brunoniana Wall. ex Sternb.
Tufted herb with yellow flowers. 3400 m, April 1982, 846.
S. diversifolia Wall. ex DC. var. **parnassifolia** (D. Don) Engl.
Erect herb with yellow white flowers. 3600 m, June 1982, 1056.
S. filicaulis Wall.
Small herb with yellow flowers. 3300 m, June 1982, 847.
S. pallida Wall. ex DC. syn. *S. micrantha*
Small shrub with white flowers. 3000 m, June 1982, 2603.

Crassulaceae

Sedum linearifolium Royle
Glabrous herb with white flowers. 3100 m, June 1982, 905.
S. trifidum Wall.
Glabrous herb with pale pink flowers. 3000 m, June 1982, 3284.

Onagraceae

Circaea alpina L.
Herb with pale pink flowers. 3100 m, June 1982, 966.
Epilobium brevifolium D. Don
Herb with pale pink flowers. 3000 m, June 1982, 3168.
E. royleanum Haussk.
Erect herb with pale pink flowers. 3000 m, June 1982, 2803.
Oenothera rosea Soland
Herb with pink flowers. 2600 m, May 1982, 903.

Begoniaceae

Begonia amonea Wall. ex DC.
Glabrous herb with pink flowers 2500 m., April 1982, 622.

Datiscaceae

Datisca cannabina L.
Glabrous herb with yellow flowers. 2700 m, May 1982, 4788.

Apiaceae

Bupleurum candollii Wall. ex DC.
Herb with white flowers. 3200 m, June 1982, 1013.

B. lanceolatum Wall. ex DC.
Herb with white flowers. 2800 m, June 1982, 3300.

Heracleum candicans Wall. ex DC.
Herb with white flowers. 3200 m, April 1982, 3747.

Pimpinella diversifolia DC.
Herb with white flowers. 2900 m, June 1982, 1051.

Selinum wallichianum (DC.) Raizada & Saxena
Herb with white flowers. 3300 m, June 1982, 2629.

ARALIACEAE

Hedera nepalensis K. Koch.
Climbing shrub with yellow flowers. 2700 m, April 1982, 954.

CAPRIFOLIACEAE

Leycesteria formosa Wall.
Bushy shrub with white flowers. 2700 m, June 1982, 963.

Lonicera quinquelocularis Hardw.
Shrub with white flowers. 3000 m, May 1982, 965.

Viburnum cotinifolium D. Don
Small tree with white flowers. 2700 m, April 1982, 964.

V. foetens Decne.
Shrub with white flowers. 3000 m, April 1982, 896.

V. stellulatum Wall.
Small tree with white flowers. 2800 m, May 1982, 894.

RUBIACEAE

Galium aparine Linn.
Climbing herb with white flowers. 3000 m, April 1982, 1105.

G. asperifolium Wall.
Herb with white flowers. 2700 m, June 1982, 887.

G. rotundifolium Linn.
Small herb with minute white flowers. 2900 m, June 1982, 888.

Leptodermis lanceolata Wall.
Shrub with pinkish purple flowers. 2700 m, June 1982, 1772.

VALERIANACEAE

Valeriana hardwickii Wall.
Aromatic herb with white flowers. 3300 m, June 1982, 2623.

V. jatamansi DC.
Aromatic herb with dull white flowers. 2800 m, May 1982, 519.

DIPSACACEAE

Dipsacus mitis D. Don
Herb with white heads. 3300 m, June 1982, 648.

Morina longifolia Wall.
Prickly herb with deep pink flowers. 3300 m, June 1982, 687.

ASTERACEAE

Anaphalis busua (Buch.-Ham. ex D. Don) Hand-Mazzetti
Erect woolly herb with full yellowish flowers. 2500 m, April 1982, 607.

A. contorta Hook. f.
Erect woolly herb with small dense dirty white flowers. 3000 m, June 1982, 604.

Artemisia vestita Wall.
Herb with whitish flowers. 2700 m, June 1982, 910.

A. vulgaris Linn.
Herb with white grey flowers. 2900 m, June 1982, 2209.

Aster peduncularis Wall. ex Nees
Herb with purple blue flowers. 2700 m, April 1982, 3201.
Cirsium involucratus DC.
Robust herb with dull yellow flowers. 3000 m, June 1982, 2648.
Dichrocephala integrifolia (W. Ait.) Kurtze
Erect herb with whitish flowers. 2700 m, June 1982, 775.
Erigeron alpinum Linn.
Herb with pinkish yellow flowers. 2700 m, April, 1982, 663.
Inula cappa (Buch.-Ham. ex D. Don) DC.
Shrub with yellow flowers. 2800 m, May 1982, 1982.
Jurinea macrocephala (DC.) Clarke
Herb with sessile purplish heads. 2800 m, June 1982, 2891.
Myriactis wallichii Less.
Branched herb with whitish yellow flowers. 2700 m, June 1982, 917.
Senecio alatus Wall. ex DC.
Pubescent herb with dirty brown pappus. 3100 m, June 1982, 737.
S. chrysanthemoides DC.
Erect glabrous herb with yellow flowers. 3100 m, June 1982, 2633.
S. nudicaulis Buch.-Ham.
Glabrous herb with yellow flowers. 3000 m, May 1982, 811.
Solidago virga-aurea Linn.
Herb with deep yellow flowers. 2700 m, June 1982, 1900.
Taraxacum officinale (Weder.) Wiggers
Herb with white flowers. 2700 m, April 1982, 1096.
Tanacetum longifolium Wall. ex DC.
Aromatic herb with yellow corymbose heads. 3100 m, June 1982, 1088.

Campanulaceae

Campanula colorata Wall.
Erect herb with blue flowers. 2700 m, April 1982, 908.

Ericaceae

Cassiope fastigiata D. Don
Erect herb with drooping dull yellow flowers, 3300 m, May 1982, 2725.
Gaultheria trichophylla Royle
Small herb with white flowers. 3200 m, May 1982, 666.
G. nummularioides D. Don
Small herb with pink flowers. 3300 m, June 1982, 1071.
Rhododendron anthopogon D. Don
Small shrub with dull yellow flowers. 3200 m, June 1982, 2727.
R. arboreum Sm.
Tree with red flowers. 2700 m, June 1982, 1041.
R. campanulatum D. Don
Small tree with light pink flowers. 3300 m, June 1982, 2728.
Lyonia ovalifolia (Wall.) Drude
Tree with white flowers. 2500 m, April 1982, 991.

Primulaceae

Androsace lanuginosa Wall.
Silky villous herb with purple flowers. 3100 m, June 1982, 603.
A. rotundifolia Hardw.
Herb with pink purple flowers. 3200 m, April 1982, 1015.
Lysimachia pyramidalis Wall.
Glabrous shrub with pale purple flowers. 2700 m, June 1982, 792.
Primula denticulata Sm.
Herb with pinkish purple flowers. 3300 m, May 1982, 1033.

P. petiolaris Wall.
Herb with purple flowers. 3300 m, May 1982, 699.

MYRSINACEAE

Myrsine africana Linn.
Shrub with light reddish coloured flowers. 2700 m, June 1982, 1518.

OLEACEAE

Fraxinus micrantha Lingelsh
Tree with drooping white flowers and samara fruit. 2500 m, May 1982, 4715.

Syringa emodi Wall. ex G. Don
Small tree with white flowers. 2800 m, April 1982, 744.

ASCLEPIADACEAE

Cynanchum glaucum Wall.
Hairy herb with yellow flowers. 2700 m, May 1982, 770.

C. vincetoxicum Pers.
Herb with yellowish flowers. 2900 m, June 1982, 1067.

GENTIANACEAE

Gentiana argentia (Royle ex D. Don) DC.
Herb with white flowers. 3000 m, April 1982, 1021.

G. capitata Buch.-Ham. ex D. Don
Erect herb with whitish purple streaked flowers. 3200 m, April 1982, 995.

Swertia cordata Clarke
Erect herb with white marked purple streaks on the margins of flowers. 3300 m, April 1982, 1403.

BORAGINACEAE

Cynoglossum glochidiatum Wall. ex Benth.
Erect hairy herb with deep blue flowers. 2700 m, June 1982, 929.

C. microglochin Benth.
Herb with dark blue flowers. 2800 m, June 1982, 1759.

Onosma emodi Wall.
Densely hairy herb with light pink flowers. 3100 m, June 1982, 2602.

SOLANACEAE

Datura stramonium Linn.
Erect glabrous herb with white flowers. 2500 m, May 1982, 1775.

Physalis minima Linn.
Erect herb with yellow flowers. 2400 m, June 1982, 4077.

SCROPHULARIACEAE

Hemiphragma heterophyllum Wall.
Hairy herb with pink flowers. 3200 m, June 1982, 1030.

Pedicularis carnosa Syn. *P. bifida* Wall.
Herb with pink flowers. 2800 m, June 1982, 925.

P. hoffmeisterii Klotz.
Herb with pink flowers. 2800 m, June 1982, 713.

Picrorhiza kurrooa Royle ex Benth.
Spreading herb with bluish flowers. 3100 m, June 1982, 804.

Veronica agrestis Linn.
Herb with blue flowers. 2600 m, April 1982, 1010.

V. cana Wall.
Herb with blue flowers. 3200 m, April 1982, 744.

ACANTHACEAE

Strobilanthes dalhousianus Clarke
Herb with dark blue flowers. 2600 m, June 1982, 1954.

S. atropurpureus Nees
Herb with blue flowers. 2700 m, June 1982, 742.

Lamiaceae

Calamintha umbrosa Benth.
Herb with pinkish flowers. 3200 m, June 1982, 638.
Elsholtzia polystachya Benth.
Aromatic herb with pale yellow flowers. 2700 m, June 1982, 944.
E. strobilifera Benth.
Herb with pale purple flowers. 2800 m, June 1982, 2668.
Salvia nubicola Sweet
Hairy herb with pale yellow flowers. 2700 m, June 1982, 950.
Nepeta govaniana Benth.
Erect herb with yellow flowers. 2800 m, June 1982, 1055.
Origanum vulgare Linn.
Erect herb with pink flowers. 2700 m, June 1982, 2932.
Phlomis bracteosa Royle
Hairy herb with dull yellow flowers. 3100 m, June 1982, 715.
Thymus serpyllum Linn.
Aromatic hairy herb with purple flowers. 3100 m, May 1982, 700.

Plantaginaceae

Plantago major Linn.
Herb with green spikes. 2900 m, April 1982, 806.

Amaranthaceae

Achyranthes aspera Linn.
Herb with white flowers. 2700 m, June 1982, 2169.
Cyathula capitata Moq.
Herb with white flowers. 2700 m, June 1982, 3881.

Polygonaceae

Oxyria digyna Hill.
Glabrous herb with green pink flowers. 3100 m, June 1982, 692.
Polygonum alatum Buch.-Ham.
Herb with white flowers. 3200 m, April 1982, 680.
P. amplexicaule D. Don
Glabrous erect herb with red flowers. 3000 m, June 1982, 985.
P. polystachyum Wall.
Shrub with white tinged pink flowers. 2800 m, June 1982, 2636.
P. sinuatum Royle
Creeping glabrous herb with pink flowers. 2900 m, June 1982, 2637.
Rheum emodi Wall. ex Leisson
Herb with white flowers. 3200 m, June 1982, 2804.

Thymelaeaceae

Daphne oleoides Sehreb.
Shrub with white tinged pink flowers. 2700 m, June 1982, 658.

Euphorbiaceae

Buxus sempervirens Linn.
Small tree with yellow green flowers. 2700 m, April 1982, 4722.
Sarcococca pruniformis Lindl.
Glabrous shrub with pale yellow flowers. 2700 m, April 1982, 731.

Urticaceae

Urtica parviflora Roxb.
Erect herb with small green flowers. 2700 m, June 1982, 2003.

Pilea umbrosa Wedd.
Hairy herb with minute green flowers. 2800 m, June 1982, 719.

Betulaceae

Betula alnoides Buch.-Ham.
Tree with male and female catkins 4″ long. 2600 m, June 1982, 4701.
B. utilis D. Don
Tree with male and female spikes 3″ long. 3200 m, June 1982, 4709.

Fagaceae

Quercus himalayana Bahadur
Tree, fruit ovoid, half burried in the cup, 2500 m, June 1982, 4731.
Q. semecarpifolia Smith
Tree with dark brown smooth and globose nut. 2700 m, June 1982, 1084.

Salicaceae

Salix elegans Wall. ex Anders.
Small tree with yellow or pale green catkins. 3100 m, April 1982, 4789.
S. hastata Linn.
Small tree with densely black catkins. 3300 m, April 1982, 4791.

Pinaceae

Abies pindrow Sach.
A large deciduous tree with light green foliage. 2600 m, April 1982, 4701.
Pinus excelsa Wall.
Tree foliage grey green with cylindric cones. 2800 m, April 1982, 4790.

MONOCOTYLEDONS

Orchidaceae

Epipactis latifolia Linn.
Erect leafy herb with yellow white flowers. 2800 m, June 1982, 4093.
Goodyera repens R. Br.
Leafy herb with white flowers. 3000 m, May 1982, 968.
Habenaria ensifolia Lindl.
Herb with pale white flowers. 2500 m, June 1982, 670.
H. marginata Colebr.
Glabrous herb with yellow flowers. 2700 m, June 1982, 3347.
Herminium angustifolia Benth.
Herb with green flowers. 2600 m, June 1982, 675.
Cypripedium cordigerum D. Don
Glabrous herb with green flowers. 2800 m, May 1982, 769.
Oberonia platyrachis Rchb. f.
Succulent leaved herb on tree trunks. Spike with cylindric fleshy rachis, minute flowers depressed in it. 2700 m, June 1982, 4792.
Satyrium nepalense D. Don
Erect glabrous herb with pink flowers. 2600 m, June 1982, 3229.

Scitamineae

Cautleya lutea Royle
Herb with green flowers. 2600 m, June 1982, 624.
Roscoea alpina Royle
Erect herb with dark purple flowers. 3200 m, June 1982, 727.
R. procera Wall.
Erect herb with dark purple flowers. 3100 m, June 1982, 3303.

Iridaceae

Iris kumaonensis Wall. ex D. Don
Small herb with bright lilac flowers. 3200 m, June 1982, 1032.

Liliaceae

Gagea lutea Schult.
Small herb with yellow flowers. 3000 m, June 1982, 2743.

Polygonatum cirrifolium Royle
Glabrous herb with white flowers. 2900 m, June 1982, 1061.

Smilax glaucophylla Klotzsch
Climbing shrub with purple flowers. 2700 m, April 1982, 990.

S. pallida Royle
Herb with white flowers. 2900 m, June 1982, 2742.

Juncaceae

Juncus consinnus D. Don
Herb with dark brown flowers. 3000 m, June 1982, 679.

J. elegans Royle ex D. Don
Herb with white flowers. 3200 m, June 1982, 2649.

Luzula multiflora (Retz.) Lef.
Hairy herb with brown flowers. 3300 m, June 1982, 2830.

L. spicata DC.
Herb with dark brown flowers. 3300 m, June 1982, 2874.

Araceae

Arisaema intermedium Blume
Erect herb with green purple and white striped spathe. 3100 m, June 1982, 3891.

Typhonium diversifolium Scholt ex Lindl.
Erect tuberous herb with purple striped spathe. 2900 m, May 1982, 1022.

Cyperaceae

Carex breviculmis R. Br.
Grass with green spickes. 3000 m, June 1982, 1028.

C. condensata Nees
Grass with red brown spikes. 2900 m, June 1982, 4793.

C. neiogyna Strachy
Grass with red brown spikes. 2900 m, June 1982, 4794.

C. setigera D. Don
Grass with brownish spike. 3100 m, June 1982, 2748.

Eriophorum comosum Wall. ex Nees
Erect herb with brown spikes. 2800 m, April 1982, 1998.

Poaceae

Agrostis alba Linn.
Grass with shining green spikes. June 1982, 3100 m, 4795.

A. canina Linn.
Grass with purple green panicles. 3200 m, June 1982, 2642.

A. pilosula Trin.
Grass with green panicles. 3200 m, June 1982, 2654.

Andropogon tristis Nees
Erect grass with green spikes. 3100 m, June 1982, 1040.

Festuca gigantea Vill.
Grass with pale green spikelets. 3100 m, June 1982, 2880.

F. rubra Linn.
Erect grass with green spikelets. 3100 m, June 1982, 2882.

Poa annua Linn.
Glabrous grass with green spikes. 3000 m, June 1982, 2696.

P. nepalensis Wall. ex Duthie
Erect grass with green spikelets. 3200 m, June 1982, 2885.

Pennisetum orientale Rich.
Grass with light yellow spikes, 2800 m, June 1982, 1902.

Polypogon monspeliensis Desf.

Grass with yellow green spikelets. 2700 m, June 1982, 4781.

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DISPLAY LEAP OF THE LESSER FLORICAN *SYPHEOTIDES INDICA*[1]

M. W. Ridley[2], R. D. Magrath[3] and J. C. Z. Woinarski[3]

(With three text-figures)

Breeding male Lesser Floricans display by giving conspicuous. fluttering leaps. From a study of floricans in the Kathiawar Peninsula, western India, we deduced the conditions and sites preferred by displaying males. They display in overcast weather throughout the day but especially in the early morning. They choose sites in open grassland, well covered with vegetation but not on high ground or small knolls. One male used nine such sites (three intensively, six occasionally) within an area of 1.2 ha. It displayed for an average of 17.3 minutes at each site and spent 38% of the day displaying. We speculate that the display is designed to attract females and advertise territory ownership to males, while minimising exposure to potential predators.

Introduction

The Lesser Florican or Likh *Sypheotides indica* is a small bustard which breeds during the monsoon in the grasslands of western and central India. Dharmakumarsinhji (1950) has described various courtship displays performed by males, the commonest of which is a conspicuous, fluttering leap about 2 m into the air repeated at regular intervals. The male squats and then springs upwards with a series of shallow wing beats, inflating its neck and throwing back its head, simultaneously uttering a loud rattle. It then folds its primaries and falls back to the ground with its white shoulders, black neck and underparts and yellow legs clearly visible. During a survey of Lesser Floricans in the Kathiawar Peninsula, Gujarat, in July to September 1982 (Magrath *et al.* 1983), we observed this display on many occasions. We report here details of factors affecting the frequency of displays and the choice of display sites. We speculate that this and other aerial displays in the bustard family differ among species in the height of the leap and the frequency of repetition, depending on the vegetation in which the species lives.

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Study area and methods

Displaying male floricans were watched on 69 occasions at 21 separate sites throughout western Kathiawar. All were on or close to 'vidis' (ungrazed, natural grasslands used for hay production). For each displaying bird seen, we noted as many of the following details of weather, display rate and site as possible.

A. Weather: cloud cover (fraction of the sky covered by cloud in eighths); wind speed (to the nearest 5 knots); rainfall (on a subjective scale from 0 to 3); light intensity (camera lightmeter reading when pointed at the horizon due north with 35 mm lens, at ASA 64, 1/125 sec.).

B. Display rate: number of leaps per 10 minutes (at 30 minute intervals); intervals between leaps, in seconds.

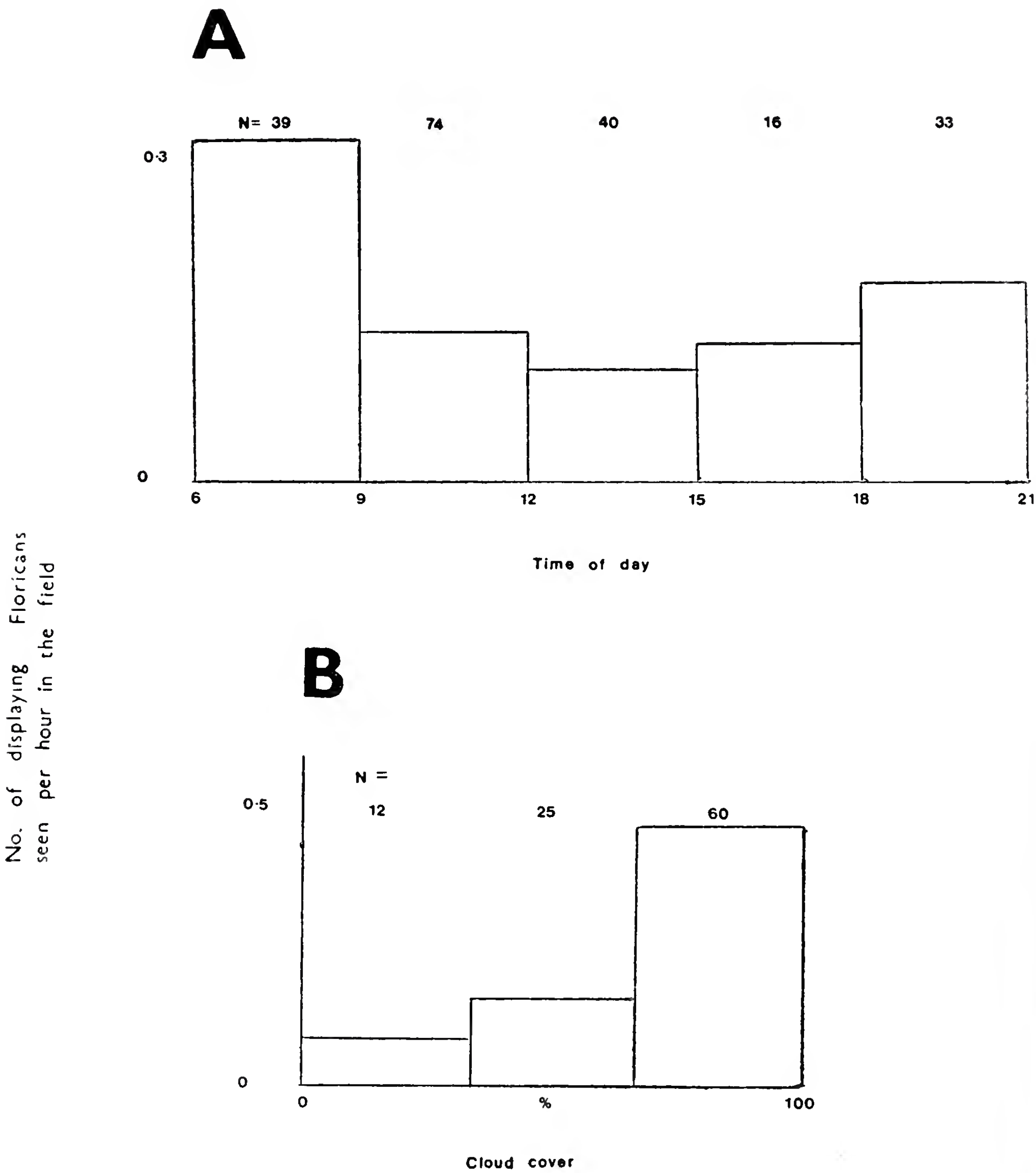

Fig. 1A. Florican display frequency at different times of day.
Fig. 1B. Florican display frequency in different weather conditions.

C. Sites: evidence of regular use (trampled grass, bare ground); topography (whether high or low relative to areas within 500 m and whether concave, level or convex relative to areas within 30 m); substrate (% stones); grass thickness (height and percentage cover of grass); shrub density (distance to the nearest shrub and number of shrubs within 30 m).

For detailed analysis of display behaviour we watched one male from a hide for a total of 42.5 hours on eight days between July 27th and August 17th. The hide was occupied from 0600 to 1100 or from 1300 to 2000. This male displayed at nine sites on a small, plateau-shaped vidi at Harshadpur, near Jamnagar. At least two other males and one female were seen on the same vidi.

Results

In this section one display refers to one leap. A bird was defined as displaying if it made at least one leap every ten minutes. In practice, the repetition rate was usually higher.

Display rates

Two factors are reported to affect the frequency of displaying: time of day and cloud cover (Dharmakumarsinhji 1950, Goriup and Karpowicz 1981). Figure 1*a* shows the frequency of displays recorded at different times of day relative to the number of hours spent in the field. While it was true that floricans were more likely to display in the early morning than at other times, the effect was only just significant ($X^2 = 11.01$, $n = 4$, $P < 0.05$), and display behaviour was recorded at all hours.

The effect of cloud cover was more marked (Figure 1*b*). Displays were more often seen in overcast weather ($X^2 = 7.9$, $n = 2$, $p < 0.05$). Display rates were also higher when the sun was hidden by cloud (Table 1). This preference is well known (Dharmakumarsinhji 1950). Our results suggest that cloud cover itself is a more important factor than time of day or light intensity. Heavy rainfall did prevent floricans displaying, but after a storm they usually displayed at a high rate.

TABLE 1

INTERVALS BETWEEN LEAPS WERE SHORTER WHEN THE SUN WAS HIDDEN BY CLOUD

Weather	Sample size (N)	Interval (secs) ($\bar{x} \pm 1$ s.d.)
Sun behind cloud	323	57.83 ± 40.23
Hazy or bright sunlight	65	76.20 ± 43.66

$t = 3.13$, $p < 0.002$.

The Harshadpur male displayed for 38% of the 42.5 daylight hours it was watched. While displaying, it averaged one leap every 61 seconds (Figure 2). Longer intervals between leaps were common, but intervals shorter than 20 seconds were rare. Nevertheless, we did see it leap as little as 2 seconds after landing from the last leap. Such bouts of rapid display were often (perhaps always) caused by a female florican flying over the area (cf. Dharmakumarsinhji 1950).

Display sites

Within a vidi, males were sometimes widely dispersed but usually in sight and earshot of each other. This is consistent with Dharmakumarsinhji's (1950) opinion that each male defends a territory. A convex polygon joining the outermost display sites used by the Harshadpur male had an area of about 1.2 ha, smaller than Dharmakumarsinhji's estimate of

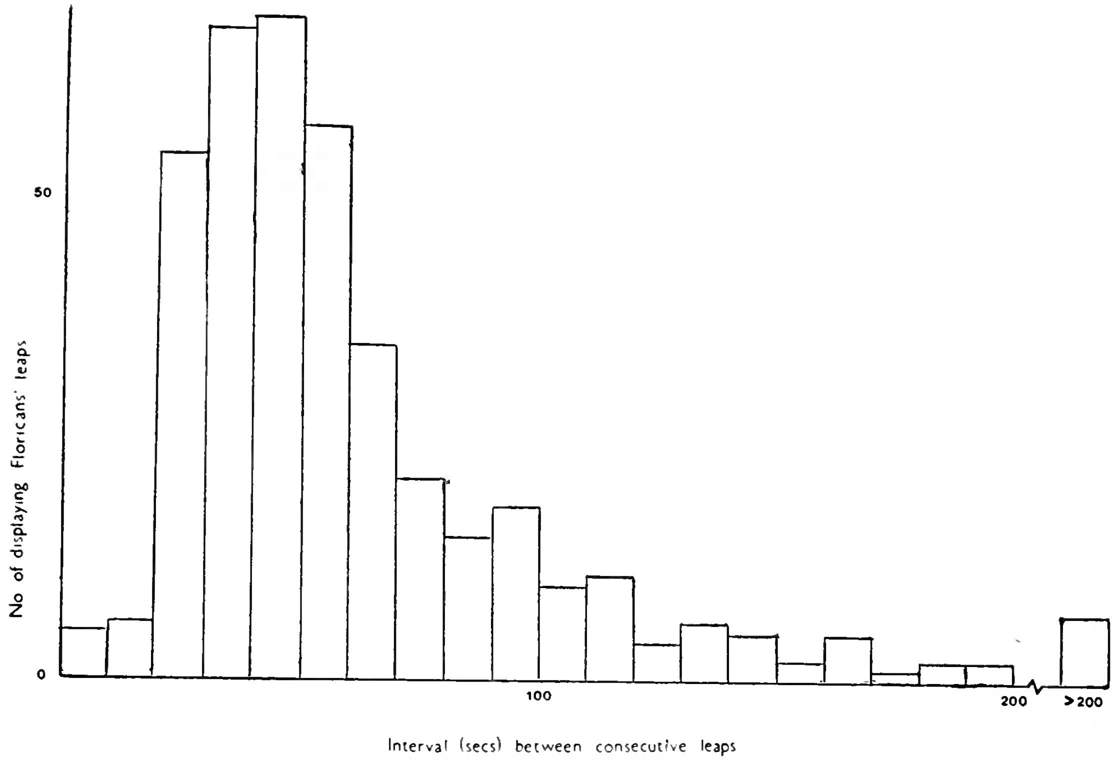

Fig. 2. Intervals between consecutive leaps of displaying male floricans.

territory size (2.5 ha). We did see aggression between males twice. In both cases a male approached another male, threatened it by raising the tail and back feathers (cf. Dharmakumarsinhji 1950) and pursued it until the second bird ran or flew away. However, we do not have evidence that the area surrounding the display sites is actually defended.

Sites were not randomly distributed with respect to topography and vegetation. Regularly used sites become trampled and bare by the end of the season (Baker 1921, Ali and Ripley 1980). To investigate how a site is chosen, we measured the intensity of use of different sites by one male and compared the position of sites with nearby habitat.

(1) *Site use.* The Harshadpur male spent 72.8% of the observed display time (969 minutes) at one of three spots; for most of the rest of the time it used six other sites, and the remaining displays were given while moving between sites (Figure 3). After displaying on one site for a mean of 17.3 (± 17.1) minutes, the bird usually walked directly to another site and began to display there (Figure 3).

(2) *Topography.* Floricans are reported to display on high ground (Dharmakumarsinhji 1950). Vidis are often in hilly areas, because these are rocky and less easily cultivated. Many are on the small plateaux which are scattered over the Kathiawar countryside; con-

sequently floricans were often found on the tops of hills. However, we recorded a preference for flat vidis (Magrath *et al.* 1983) and there was no clear preference for high situations within each vidi: compared with areas within 500 m, 18 sites were higher, 11 lower and 5 were on the same level. The site itself was usually on level or slightly concave ground. Vidis consisting mostly of sloping ground rarely held floricans (Magrath *et al.* 1983).

(3) *Vegetation.* Shrub density did not appear to be important in the choice of display sites. While floricans were commonest on open grassland (Magrath *et al.* 1983, Voinarski *et*

Table 2

Characteristics of display sites

	Sample size N	Mean value	Range
Substrate (% stones)	20	26%	0–80%
Shrub density (no. within 30 m)	28	16.07	1–80
Nearest shrub (m)	28	14.43	2–90
Grass cover (% within 5 m)	20	69%	40–90%
Grass height (cm)	25	38.8	20–60

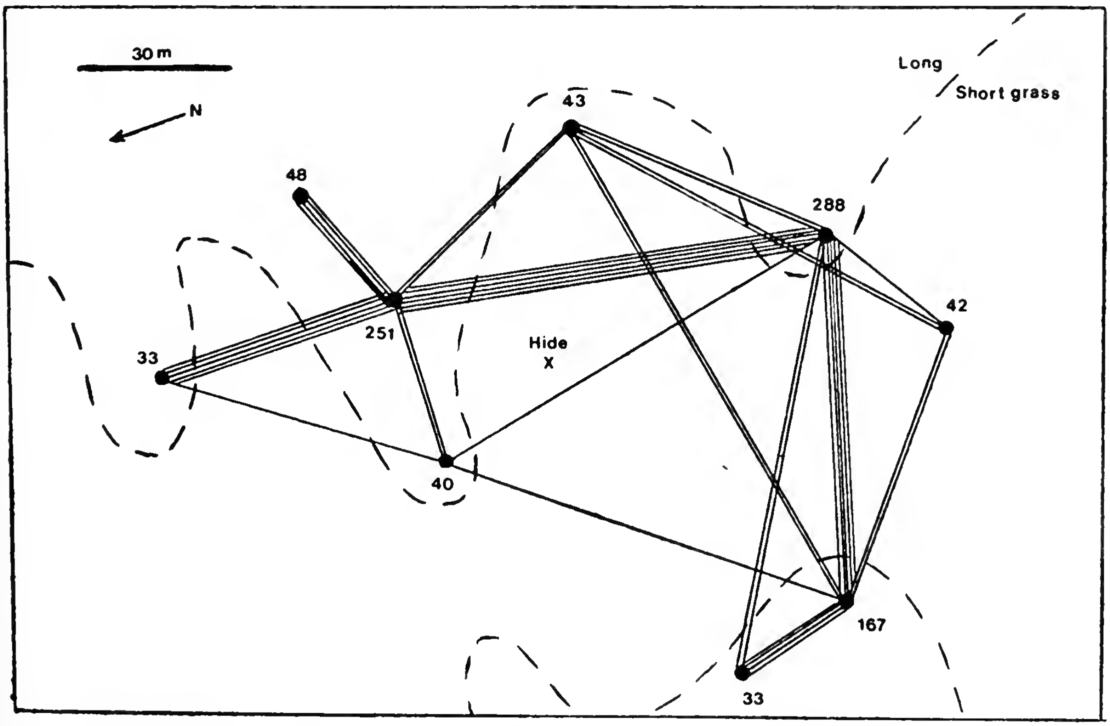

Fig. 3. Display sites of one Lesser Florican at Harshadpur, near Jamnagar. Numbers represent the number of minutes for which the bird was seen to display at each site. Each line between two sites represents an occasion on which the bird was seen to move directly from one site to the other.

al. in prep.), we also saw displaying males in scrub and open *Acacia* woodland (Table 2); on one occasion a male displayed among trees of up to 5 m in height and shrubs at a density of more than 200 per hectare. Sites were on a variety of substrates from rocky ground to soft soil (Table 2). A more important factor was grass height.

Especially in the early part of the season when grass was short everywhere, males chose sites well covered with relatively long grass (Table 2). The display sites were often in the only patches of long grass in the vicinity (e.g. Figure 3). By September, when grass was longer, males no longer preferred, and possibly even avoided, the thickest grass, as found by Hume and Marshall (1878) and Baker (1921).

Discussion

For about three months, male Lesser Floricans spend more than one-third of the day displaying by springing about 2 m into the air, at a rate of about once a minute. They probably leap more than 400 times each day. The display flight therefore represents a considerable investment of time and energy and is presumably only possible because males are emancipated from nesting duties. In addition it probably exposes the male to a substantial predation risk from birds of prey (Dharmakumarsinhji 1950). What is the function of the display?

It has been interpreted either as an advertisement display intended to attract passing females or as a territorial display advertising ownership to rival males (Hume and Marshall 1878, Baker 1921, Dharmakumarsinhji 1950). The sight of a passing female causes males to leap several times in quick succession (this study; Dharmakumarsinhji 1950). Males are probably promiscuous (i.e. form only brief pair bonds with females) since they continue to display throughout the season and are very rarely seen in pairs (this study; Jerdon 1877, Dharmakumarsinhji 1950). In the presence of a female, a male performs a different sequence of pre-copulatory ground displays (this study; Dharmakumarsinhji 1950). So the leaping display is probably intended to be as conspicuous as possible in an effort to be noticed by nearby females and/or males. Both the loud rattle — probably made by the tongue as in *Eupodotis ruficrista* (Kemp and Tarboton 1976) — and the flash of white wings during the leap are highly conspicuous to human observers.

The Indian plains can be very hot and shadeless in July and August, so males probably avoid displaying in direct sunshine because the sun heats the black body of the bird too much or because females are perhaps more active in overcast conditions. It is unlikely that dull conditions make males more conspicuous. Little Bustards *Tetrax tetrax* also prefer to display at low light intensities (Cramp and Simmons 1980, H. Schulz, pers. comm.). They are, however, more strictly crepuscular than Lesser Floricans which do not confine their displays to twilight.

The choice of display site is probably affected by two factors: effectiveness as a signal to other floricans and risk of attracting predators. Most sites we found were on relatively level ground which meant that they were visible from some distance away, both to other floricans and to predators. However, in the open vegetation preferred by displaying males, ground predators could not easily approach unseen. To avoid aerial predators such as eagles, the birds leap briefly, repeat the leap unpredictably, change sites often and remain hidden in the grass between leaps (but using the long neck as a form of 'periscope').

Other small bustards have aerial displays. At one extreme, male Little Bustards *Tetrax tetrax* leap only about 0.5 m into the air (Cramp and Simmons 1980, H. Schulz, pers. comm.). By contrast, male Red-crested Bustards (*Eupodotis ruficrista*) fly up to a height of about 30 m and 'parachute' down again (Pitman 1957, Kemp and Tarboton 1976). We suggest that the height to which males of each species leap or fly is adapted to the length of the vegetation they inhabit. Those in short, open grassland (Little Bustard, Lesser Florican) give small, but frequent, leaps, while those in savannah woodland (Red-crested Bustard, Black-bellied Bustard *Eupodotis melanogaster*, Black Korhaan *Eupodotis afra*) fly above the trees (Kemp and Tarboton 1976). In East Africa, however, Black-bellied Bustards may have two separate displays, one a short, florican-like leap, the other a long display flight (Pitman 1957). The Bengal Florican *Eupodotis bengalensis* of the Terai region in Eastern India and Nepal is intermediate: it inhabits grassland which may be up to 10 m tall and, in display, leaps 4-10 m off the ground (Baker 1921, Ali and Ripley 1980, Inskipp and Inskipp 1982). Among species, a short leap is generally associated with more frequent repetition of the display than a long flight, probably for energetic reasons.

Acknowledgements

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NOTES ON SOME COMMON BREEDING RAPTORS OF THE RAJPIPLA FOREST[1]

RISHAD NAOROJI[2]

(*With seven plates, four text-figures & a map*)

INTRODUCTION

This is a chronological account on the nesting habits of the Crested Hawk-Eagle (*Spizaetus cirrhatus*) and to a lesser extent of the Crested Serpent Eagle (*Spilornis cheela*) and the Crested Honey-buzzard (*Pernis ptilorhyncus*) based on a five and a half month study in the Rajpipla forest from 11.iii.1983 to 22.viii.1983. Male/female identification was based on size/physical characteristics and general behaviour at the nest. The Hawk-eagles' nests were generally larger and higher than those of the other two species. In most cases, a second substitute nest was observed in close proximity to the currently occupied nests. Serpent eagles were observed to occupy a new nest every season. None of their old nests observed in subsequent years could have been used as they were damaged beyond repair and re-use by the monsoon. The nests of Hawk-eagles being larger, withstood for years the onslaught of the weather.

Hatching coincided roughly with prey availability. The Hawk-eagles nest first during the dry season concluding just before the monsoon. Serpent eagles a little later, rearing young prior to and during the monsoon when snakes were more active and conspicuous. Honey-buzzards still later mainly during the monsoon when honey-combs and chameleons are plentiful and easily found. One pair of honey-buzzards near Namgir village were observed to have nested in an old (previous year's) crow's nest.

At a Serpent Eagle's nest observed in 1982 before the onset of the monsoon a variety of snakes were brought to the nest (*See* Naoroji 1983 *JBNHS 80*, No. 2). During the latter half of the nesting stage, with the monsoon firmly set in, the most frequently caught snakes were Checkered Keelbacks (*Xenochrophis piscator*) and these formed 90% of the main diet of the Mozda pair observed during the rains supplemented by other snakes and the occasional frogs (*Rana tigerina*), Lizards (*Calotes versicolor*) and bush rats (*Golunda ellioti*). The Honey-buzzards fed their young solely on Honey combs (yellowish-white in colour) and chameleons (*Chamaeleon zeylanicus*). One day an unusually high number of visits (mostly with prey) by both adults was witnessed at the nest. 14 visits in 3 hours out of which only 3 visits consisted of Honey combs being brought, the rest being chameleons (*Chamaeleon zeylanicus*). No visits were observed while it rained.

These raptors are still abundant but the forests are now under considerable pressure. Disturbances are caused during the breeding season by the following factors in this predominantly bamboo area. (1) New roads are constructed in different blocks every year by the Central Pulp Mills to facilitate the transport of bamboo to their Songardh pulp factory. Though trees are largely untouched except when building roads, the disturbance caused

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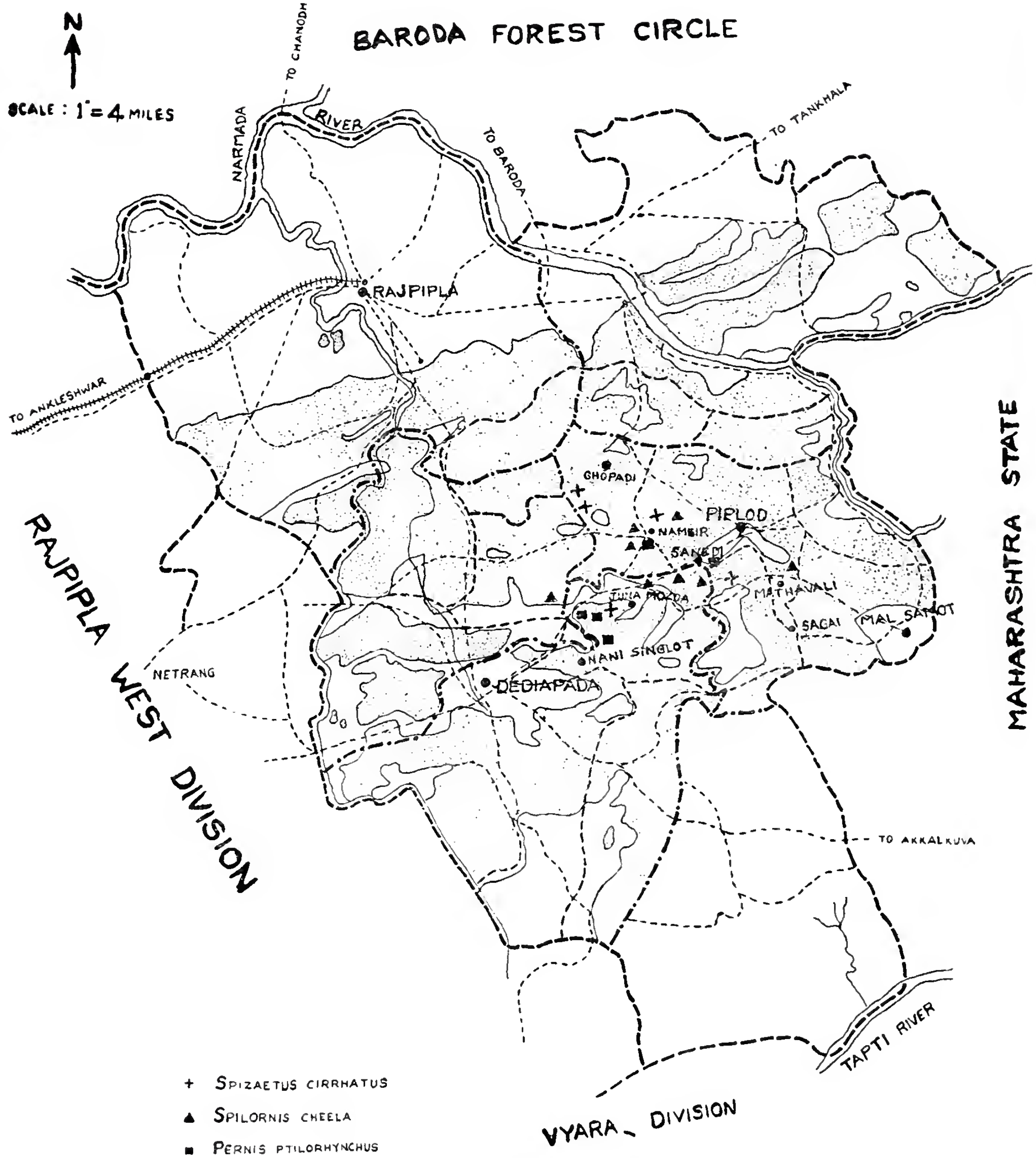
when harvesting and transporting the bamboo is considerable. (2) More alarming is the annual indiscriminate clear felling of trees for charcoal. Large tracts of mixed deciduous forest are leased out to as many as 15-25 societies who enlist the local adivasis, to senselessly harvest this valuable resource for the incredible monetary gains it offers (Plate 1). These once forested areas, now barren as a moonscape are then converted to mono culture mainly teak. (3) The population of the adivasis has increased dramatically over the last few years. While more land is annually being put under the plough illegally and local wood poachers operate openly the authorities are turning a blind eye to this ever increasing encroachment. The forests supply the Bheels with most of their basic necessities and their dependence on these forests is considerable. Every year the sparse under-growth is burnt and over-grazing by cattle virtually leaves no cover for ground birds and mammals possibly also affecting prey preferences of some raptors. The adivasis, who once lived in harmony with their surroundings, are now jeopardising their basic existence by destroying the forests on which their survival still depends. (4) The so called development of this area for the betterment of the adivasis, e.g. bus stops, electricity, a planned network of roads etc. is making serious inroads into the last remaining good patch of forests between the Uppla Junna Raj and Namgir areas.

Spizaetus cirrhatus Crested Hawk-Eagle

Nests and Eggs

I reached the forests in mid-March when the Hawk eagles were already incubating. The Serpent eagles were by this time displaying and pairing off prior to their laying soon. Five nests of *Spizaetus cirrhatus* were found and some specifications are given in Table 1. The map shows nesting sites of the three species mentioned and illustrates how the Hawk-eagles have their nests widely spaced, commanding a larger territory. While observing an incubating Hawk-eagle pair, other raptors including the Honey-buzzard, Serpent Eagle, Shikra and Black-winged kite were seen in close vicinity to their nest. In fact from Serpent eagle nest No. 3 at Namgir the nearby nest of Hawk eagle No. 1 could be seen across the valley, both nests in close proximity to each other.

Altogether four nests of the Hawk eagle were found containing eggs. Some hawk eagles nested close to villages in more disturbed areas than others, on high isolated trees. Such was the case with nest No. 2. Most of the surrounding vegetation had been cut and a young teak plantation was maturing in the area. The nest tree was in a deep river bed and at the same level as the nest was a hillock from where one stood at almost the same height as the nest and about 50 feet away. The nest was subject to stone throwing by young boys and this bird was so shy that the incubating and later brooding female would leave the nest when villagers were more than 50 metres away. Even after the young hatched this bird brooded much less than the nest No. 1 ♀ where I found the pair less disturbed and more confiding. The male's arrival to the nest is sometimes triggered off by human disturbances or a threat to the nest. This was observed with a Serpent eagle and also with Hawk-eagle pair No. 2. The first time Hawk eagle nest No. 2 was climbed for inspection the pair became very agitated and, only when we were about 100 metres away, did the female settle down to incubate. A little later the male flew to the nest and stood there for about half a minute as if to reassure himself that everything



Map of Rajpipla east division.

was in order. Many times, though the birds could not be seen, their vocalizing gave them away as did the alarm calls of Tree-pies, Mynas, Parakeets and Palm squirrels.

from the immediate vicinity of the nest tree. All nests were usually built in the highest suitable crotch of the nesting tree and an alternative nest was usually found nearby. The

TABLE 1

NEST DETAILS OF *Spizaetus cirrhatus*

Nest No.	Nesting Tree Species	Height of the nest from the ground (in mtrs.)	Nest Measurements		
			Inside diameter	Outside diameter	Depth
(1)	*Dalbergia lanceolaria*	18.9	1.3 m	—	35 cms
(2)	*Adina cordifolia*	16	41 cms	1 m	21 „
(3)	*Adina cordifolia*	13.4	46 cms	1 m, 20 cms	45 „
(4)	*Terminalia crenulata*	15.9	31.6 cms	88 cms	20 „
(5)	*Terminalia crenulata*	19.7	32 cms	1 m, 20 cms	23 „

The nests of the Hawk-eagles were situated higher and were the largest amongst the raptor species observed. Some nests were visible from a quarter to half a mile away in high isolated trees. The table above shows that Nest Nos. 1 & 5 were the highest with Nest No. 1 being the largest, dwarfing the incubating ♀. Nest No. 3 was the lowest but larger than Nest No. 2 and contained the smallest egg. The outside circumference of Nest No. 1 was 3.45 metres. The general habitat in which the nests were located was in a dry deciduous forest interspersed with bamboo and *Strobilanthes* with no undergrowth at all and what little existed had been burnt off. Most nests were open to the sky and roughly faced east to west. The nesting trees were almost bare except for a few branches carrying green and yellowing leaves. The trees would leaf again during the monsoon. All nests were lined with green sprays. Nest No. 1 was lined with sprays from the following trees: *Dalbergia lanceolaria, Dalbergia volubilis, Pterocarpus marsupium* and *Diospyros melanoxylon.* The ♀ of nest No. 1 was observed to bring leafy sprays Hawk-eagles like the Serpent eagles and Honey-buzzards are close sitters when incubating and leave the nest when a climber is half way up a tree. Later after the eggs had hatched they would leave when we were within 100 ft. of a nest. All nest trees were situated on the higher slopes of hills.

Only one egg is laid by the Hawk-eagle. Most eggs of the same species were observed to generally hatch within a few days of each other.

Egg Measurements

	Length	Max. diameter	Weight
Nest No. 3	64.5 mm	47.4 mm	80 gm
Nest No. 5	72.2 mm	52.8 mm	100 gm
Average of 39 eggs.	67.3 mm	51.9 mm (Baker: NIDIFICATION)	

The eggs oval in shape are white and not blotched with red like the Serpent eagle's and Honey-buzzard's.

Incubation

While the ♀ Hawk-eagle was incubating

the male, when not hunting would remain in close proximity to the nest. At this time of year, day temperatures go up to 40°C and it gets progressively hotter till the month of June. In nests Nos. 2 & 3 of the Hawk-eagles, fully intact palm squirrels were found. This ensures the incubating bird has enough food in the nest to be eaten later as and when required. Late evenings after 5, when it got cooler the incubating ♀ (nest No. 2) would stand up in the nest for long periods of time. Also, visits by the male to the nest at this stage are limited and adult birds do not kill as much as when there is a fledgling to be fed. As nest No. 2 was kept under observation for most of the day with no sightings of a feeding visit it could be surmised that most of the prey was brought during the very early hours of the morning.

The exact incubation time for Hawk-eagles is not known. When I arrived on 11.iii.83, they were already incubating but we do know that incubation goes on for more than a month, probably a month and a half. Just before hatching the pipping of the young can be clearly heard and some eggs become slightly discoloured. The developed egg of Hawk-eagle nest No. 3 was found covered with leaves and $2\frac{1}{2}$ days before hatching two holes were observed on either side of the egg somewhat near the middle. This has been observed with Eleanora's Falcon and also with egg No. 4 of *S. cheela* on 25.v.83. The Hawk-eagle female of nest No. 3 appeared to be the most aggressive and would frequently feint at a climber but never actually make contact. On one occasion she flew upto 3 ft. of an assistant who was half way up the nest tree before veering off. A day later it was noticed that the slit in the shell of egg No. 3 had widened and the young could be clearly heard from inside.

At nest No. 1 the female Hawk-eagle was often mobbed near the nest by crows and at the nest persistently for a few days by a shrike. At nest No. 2 just after the female left off incubating she was mobbed so persistently by a black-winged kite that she took shelter in a foliaged tree. The black winged kite would rise to a pitch and with wings pressed tightly to its sides dive-bomb the eagle repeatedly 3/4 times. The last dive made some contact, unsettling the eagle out of the tree. Incubating birds would after long intervals leave the nest and fly out of sight. Whether the same bird returned after 10-15 minutes from a feed or whether a change-over took place is impossible to say as both adults were rarely visible together at the same time and observations were made at a great distance from a vantage point.*

Adoption of Young

On 17.iv.83 machan building commenced near Hawk-eagle nest No. 1. Fledgling's measurements and weight were restricted only to nest No. 2. The machan was eventually completed to a height of 65 ft. and took 15 days to build — an hour a day. While the machan was being built we saw the male arrive with prey in the evening on 2/3 occasions, the prey held in its talons pressed close against the body. Both adults would sometimes circle around the nest as machan construction continued. The female would then perch nearest to the nest while the male disappeared before resuming circling sometimes with prey. At other times he was seen perched close to nest

* Three of the nests under observation hatched within a few days of each other. Nest No. 1 on 10.4.83, Nest No. 2 on 8.4.83, Nest No. 3 on 17.4.83. On 17th morning pieces of egg shell were found sticking to the back of the newly-hatched Nest No. 3 young.

No. 3 of the Serpent eagle. We would leave before sundown and watch from afar, prey being fed to the young. On one occasion while machan building was in progress, we saw three adult Hawk eagles together. One slightly smaller with underside of wings paler than the other two. Occasionally one of them would effortlessly float pass close to the nest just above the tree line without flapping its wings with just the primaries upturned slightly. The wings on the whole are held in line with the body and not higher as in the case of *S. cheela* (Fig. 1).

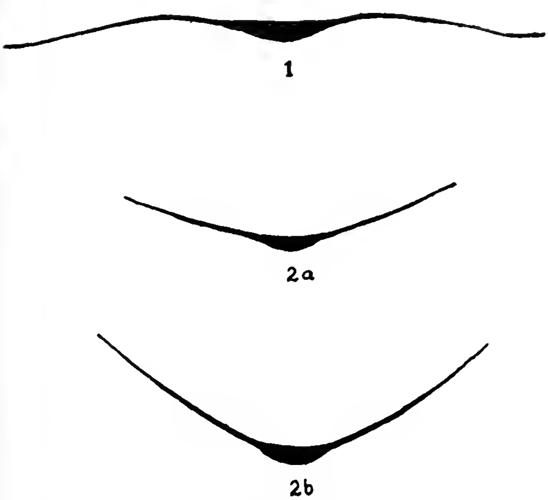


Fig. 1. *Spizaetus cirrhatus* — gliding at nest level. Fig. 2a. *Spilornis cheela* — gentle v while soaring; 2b. *Spilornis cheela* — sharp v during mating display.

The Hawk-eagle machan was completed on 29.iv.83 and after we left we watched from a safe distance the eaglet being fed and the hide accepted by the adults without any kind of apprehension. Compared to the other pairs observed, this pair had a very strong bond with the nest and were given the usual two rest days to get accustomed to the hide. The next day, on 30.iv.83, the female was observed brooding. On 1.v.83 both the adults were seen flying agitatedly above the nest the ♀ showing no intention of brooding and, not wanting to disturb them, I went to occupy the hide on 2.v.83. My apprehension proved founded and the catastrophe I inwardly feared had materialised. Nest No. 1 was empty. One of the locals as we subsequently found out for devious reasons was responsible. While Shahroukh Mistry, a Zoology student from Baroda, went to inform the Forest Dept. and the police, I took a quick decision. Nest No. 2 was a disturbed nest and even though the birds had so far managed to raise their nestling quite effectively, I did have some doubts as to the eaglet reaching maturity. Nest No. 3 and No. 4 had by this time been destroyed by vandals. As the nest No. 1 pair were still circling around in the vicinity, they obviously still had a close bond with the nest which must have been empty for over 24 hours. I then decided to immediately transfer the young of nest No. 2 to nest No. 1 as quickly and quietly as possible. If the young was not accepted after a couple of hours we decided to move it back to nest No. 2. The transfer was done silently and quickly. A common myna found intact along with the young in the nest was also transferred to nest No. 1 where the adults kept vocalizing for about ten minutes. Twenty minutes after we had left the immediate vicinity the female landed at the nest. She stood in the nest with her head deep in the nest cavity occasionally looking out. She then left the nest and came back after an hour making an attempt to sit on the young which appeared to rebuff her. She flew off and later made two visits, firstly perching on the nest for a few seconds before flying away and later perching on the nest tree for about a minute. After 2 p.m. she brooded the young almost continuously till

7 p.m. except when she left to arrive soon after with prey. 2/3 feeding sessions were observed in the afternoon, the last at 6.45 p.m. At 7 p.m. as it was getting dark we left the female brooding the young for the night. The immediately accepted nestling, was on the day of its adoption 24 days old and eventually flew from the nest fully fledged. This nest was immediately given adequate protection and the offending tribal dealt with.

Growth of Nestling

Intensive brooding is characteristic with raptors throughout the first post hatching 15 to 25 days after which in the case of Hawk-eagles the female would perch a few feet from the nest or on the nest rim without actually brooding but keeping a close protective watch, mainly during the cool morning and late evening hours when the sun's rays lose their strength and sometimes remaining even so after dark.

On 22.iv.83 the Hawk-eagle young of nest No. 2 later adopted at nest No. 1 was 14 days old and weighed 300 gm. It was in the preliminary downy stage, the down being soft and sparse with the skin showing through. Its wing stubs were also covered with down as also the tarsus. There was hardly any down on the belly. Eyes black, lores greyish black, toes creamish or yellowish-white tinged with light green. When I imitated the adults' call the young attempted to raise itself on its feet taking support with its stubby wings.

20 *days*: on 28.iv.83 the young weighed 450 gm. Initial quill like black feathers had already sprouted from under the down on the head and back. The feet appeared to be overly large and strong in proportion to the body. At this stage the young had a vocabulary of 'cheep's of different durations and pitch. Some cheeps were rendered in quick staccato.

25 *days*: Black feathers could be seen sprouting on wing edges and scapulars. The fledgling would doze a lot occasionally adjusting its position and sometimes glaring balefully at the ♀ who broods standing. The young even at this early stage would preen itself by sitting on its rump with feet outstretched and talons facing outwards and sometimes curling between the feet of the ♀ and under her breast. It even managed to stand up for a few secs., stretching its wings downwards for balance and support. Parental calls would herald the arrival of prey and at such times the young roused itself becoming extremely alert. Whenever hungry and impatient for a feed a 3-note call metallic and vaguely similar to adults in pitch and call was uttered. 90% of prey brought to the nest was fed to the eaglet, the ♀ taking occasional mouthfuls. Small slivers of meat held out at the tip of her beak were taken with great speed and accuracy. Large pieces were also gulped down and hungrily swallowed. The young was normally fed 4-5 times a day. Mostly fleshy portions were fed to the young and at 25 days old the young was observed swallowing half a lizard (abdomen and tail), taking 2½ minutes. A feed was usually followed by deep slumber lasting 30 minutes to an hour before the young would usually wake up to defecate in the manner of all young raptors. The day temperatures being very high it was a wonder how the fledgling did not get dehydrated. A young captive Hawk-eagle was known to drink water copiously. During the hot months from March to June adult Hawk-eagles have been observed and filmed drinking at water holes.

30 *days*: When a month old the young's attention would be occupied with its surroundings. With this awareness that all raptor young exhibit at the same age the young watched

with fascination a pair of Serpent eagles circling overhead, a sunbird flitting above the nest, parakeets calling noisily, a shrike mobbing the ♀ etc.

When it felt threatened it would sink down into the nest cavity like Serpent eagle and Honey-buzzard young observed from this age onwards till they leave the nest. The young would often stand up for a few minutes as its feet were getting stronger. After the initial emergence of feathers from the down, they grow rapidly.

32 *days*: At 32 days old on 10.v.83 quill like feathers emerging from the down on wings, crown and faintly on rump were clearly visible. On scapulars black feathers were visible sprouting in an oval shape. Tail feathers had also begun to emerge. At the base of where the scapulars were emerging through the down, inch long tuft of feathers were now visible. Upper part of wings looked mottled with black and white. Here the feathers were growing very rapidly. The primaries growing faster than the secondaries. Under side, from neck down to tibia was white down.

The young was now being brooded less except during the hot hours and feather growth had generally accelerated.

On seeing or hearing the adults the eaglet calls out a metallic almost fluted 4 to 5 note call "Kwe Kwe Kwe Kwe Kwe" very vaguely resembling the adult's. It could now stand up comfortably when scanning the sky for the adults. During the hot hours when it was sometimes not brooded, it chose the shadiest spot in the nest. When 32 days old the young once swallowed the leg of a ground bird intact with most of the tarsus, toes and claws. Sometimes food brought to the nest was not fed immediately and the eaglet performed begging gestures, turning its head sideways to the left and the right all the while pecking ineffectively at the prey and staring at the ♀. At such times the young attempted to eat though totally ineffectively on its own, observed attentively by the ♀. L. Brown writes in 'Eagles' that a month old downy young of the African Crowned Hawk-eagle was able to tear and feed on prey independently of the adults having to spend at least another month in the nest. Not so with *Spizaetus cirrhatus.* This delaying feeding behaviour by the ♀ was noticed for the first time when the eaglet was 34 days old.

35 *days*: At 35 days brownish feathers were visible on the underside of the neck, breast, abdomen and wings as brownish streaks. Upper side of wings were now almost completely covered with feathers. The young was still being brooded at this stage, though for lesser periods of time and was rapidly increasing in size. After 28.v.83 when the young was 50 days old and still hesitant to feed itself, brooding was restricted to the hottest hours. It had also just begun to stretch and exercise its wings leaping up and down vertically facing into gusts of wind. The eaglet now began to demonstrate an effective threat display when disturbed at the nest. A much younger Serpent eaglet was observed to give a very aggressive threat display when about three weeks old and still very much in the secondary downy stage. The Hawk-eaglet displayed aggressiveness by crouching low on its posterior and with wings outstretched, beak open and claws facing outwards at the ready, and calling while thus demonstrating until the intruder left. The ♀ would, while a climber was inspecting the nest, swoop past menacingly sometimes close enough to hear the wind through her feathers. Around this time in May the Honey-buzzards were incubating while Serpent eagles were rearing downy young. When 50 days old the young could stand comfortably and was observ-

ed standing at the edge of the nest for half an hour. Young is now rarely brooded while being occasionally accompanied at the nest by the ♀ for short periods of time. On 30.v.83 at 52 days when the young was 6½ weeks old it weighed 1.3 kg. Bill length was 24.13 mm while body length (bill to tip to cloaca) was 33 cms. Lores were greyish white like an ageing beard. Toes were greenish yellow and claws black while the bare skin on joint of tarsus and tibia was greenish yellow. Down was visible on chin and throat to upper breast, abdomen & under tail, and under side of wings. Head was light brown covered with small light brown feathers tipped with white. Centre brown head feathers showed black streaks. Body feathers on neck, abdomen, wings, tail and back were light brown tinged with black and tipped with white. Wing 27 cms. Primaries dark brown to almost black tipped with white, calamus of primaries bare and blue on the under side of wings and appeared to be strong and thick. Secondaries light brown tinged with black and tipped white. Tail feathers 15 cms. long while the under side of tail feathers resembled the primaries and under tail coverts consisted of fluffy light brown feathers. Under side of primaries and tail had alternating horizontal bands of black and dirty white. Upper tail coverts were brown while upper side of tail was black tipped with white. The dorsal parts of the eaglet were by this time completely covered with feathers except for the lower back region having some down. Mouth pink, the Iris grey with black pupils, nictitating membrane white, tarsus white with light brown streaks.

The young was silent and co-operative during handling though an initial vigorous threat display was performed at the nest. It continually made use of gusts of wind by vigorously flapping its wings into the wind and leaping up higher and higher. Usually these exercises ended with three noted calls. The eaglet appeared to be about three-quarters the size of the ♀. When prey was left in the nest the young would call and peck at the prey even at this stage rather ineffectively. It could not as yet readily feed itself easily and was offered small bits of meat by the ♀. Some young become independent and learn to feed themselves earlier than others. At 55 days old it was observed that the ♀ was not accompanying the young at night but the exact date when this occurred is not known. When a bait killed by the ♀ but not eaten was being placed in the nest, the 59 days old young adopted its threat display in a crouched position when the climber was half-way up the nest tree. When the climber reached the top the young stood upright with open beak and spread its wings. Its tail was fanned out and cocked at 45° to the body. The eaglet first stood as far away as possible from the dead bait and warily observed it for 3-4 mins. It then sat down and appeared unconcerned after which it tried to pluck out the tail feathers. It then tried to break off pieces of the half eaten calotes present in the nest (which had been brought earlier by the ♂) unsuccessfully. Observing the prey from all possible angles it later called "Kwee kwee Kwee kwee" softly in a begging tone entreating the ♀ to feed it, after it had failed to feed itself. However it fed for 5 minutes tearing up the soft belly but could not rip off the tail from the hind legs. At 7.20 p.m. on this very day the ♀ arrived triggering off a begging display that continued right through her feed as she fed on the prey without offering a morsel to the young which twice tried to forcibly tear off meat from the prey. The ♀ then getting a good purchase on the remains of the bait flew off to a nearby perch 300 metres away to roost

for the night. On 14.vi.83 when the young was 67 days old it was found perched outside the nest at the end of the nest-supporting branch. On seeing us it hopped back to the nest and sat close. This common self-preservation trait is instinctive and inborn in eaglets of all species and observed also with *S. cheela* and *Pernis ptilorhyncus.* On 15.vi.83 it was still being fed and took a great interest in its surroundings spending most of its time outside the nest on the branches above it or supporting it, regularly exercising its wings. Young at this stage was ever alert and active and it could recognize its parents high up in the sky. The eaglet called on recognising its parents but never called when another pair of *S. cheela* were circling high up above the nest. The young was now the best indicator to the adults' proximity and approach to the nest. At 67 days the crest feathers were just beginning to emerge while there was more white on the nape than anywhere else on the head. On the back a single patch of down was still visible through the feathers. Its calls though weak and not penetrating like the adults', resembled now the adults' in pitch and tone. On 16.vi.83 when 68 days old the first flight of the young was observed. After a morning's heavy rain the hide was occupied at 2.16 p.m. The eaglet was not in the nest but 40 ft. away on an Aasun (*Bridelia retusa*) tree showing no fear as we climbed the machan. We also spotted the ♀ 50 yards away in the valley below. As the ♀ changed her position mobbed and followed by crows, the young excitedly moved a few feet away and looked around eagerly as if anticipating a visit. Young looked inquiringly in the female's direction and hesitatingly at the nest, hopping in stages to nearby branches looking all around. It later called "Phew Phew Phew" and then "Phew Phew Phew Phew" the first note being the longest and fading out in the last. It again called impatiently and not getting any response flew towards the ♀ away from the nest at the edge of the valley. To get to the ♀ the young would have to fly 150 yards across the valley to the other side. Seven minutes later it flew non-stop to the nest from that tree, a distance of 40 ft. It didn't quite reach the nest-rim and clinging to the side of the nest scrambled up on to the nest with a lot of wing flapping. It then looked around and called, watching a pair of white bellied drongos calling above the nest tree and occasionally played with sticks and leaves in the nest. The sticks were picked up in the beak with one end held firmly by a foot while it tried to snip the ends off with sideway motions of the head as it would later twist and cut through the neck of a victim. This pouncing on sticks and teasing act was performed with great enthusiasm and wing flapping. The sound of cattle below warily made it sit close and when one of the cows stumbled the young actually flinched at the sound of hoof striking stone. A lot of variations were now apparent in its calls. Sometimes the young would revert back to the cheeping of the downy days. On other occasions a total of 6-8 notes were heard in each call, each note different from the other. Some calls rose in pitch with changing notes, others faded towards the end of the calls. When 70 days old the young was observed calling with great intensity. Desirous for a feed the young replied to the ♀'s calls with frantic impatient vocalising. These were the most powerful vocalisations as yet heard from the young. These calls were however ignored by the ♀ who did not reply. Much of its time was spent in preening, mainly the breast feathers and sometimes comically twisting its head almost 300 degrees to look at a sun-bird flitting above the nest. At this almost fully fledged

stage the young goes on long exploratory hopping expeditions to the branches above the nest. Should an adult be spotted flying in with prey it immediately hopped down to the nest calling wildly. Prey is seized immediately in the talons with wings widespread and a begging gesture adopted by crouching with head up looking beseechingly at the ♀ (plate 1). The young, now mostly left alone with prey was seen on 17.vi.83 to eat a lizard competently and was also able to tear off the whole tail from the base. From 17.vi.83 till 25.vi.83 the eaglet, though it would leave the nest tree, was still dependent on the nest. On 24.vi.83 the young was located 200 metres away across the valley opposite the nest tree. It then flew to a perch 70 metres from the nest. Ten minutes later the ♂ dropped a Calotes in the nest following which the young called and flew eagerly to the nest coming in very fast and appropriating the whole nest making the male fly off immediately. The ♀ arrived later to feed. Though the young could clumsily feed itself at this stage it was still being fed. From 26.vi.83 there was no sign of the eaglet now using the nest though seen nearby and by 28.vi.83 we were sure that the young was totally independent of the nest. The machan poles however were covered with droppings so the young must have been using the machan occasionally as a perch. The young stayed dependent on the nest for a total of 81 days just about 2½ months.

At nest Nos. 1 & 2 light brown headed young were seen in the vicinity and on occasions very close to the currently occupied nests. The juvenile seen near nest No. 2 appeared to be a first year bird while the one observed near Nest No. 1 appeared to be an older bird — probably in its second or third year. Its plumage was similar to the adults though it was moulting but its head was light brown. It was also observed hunting capably. Two weeks before my departure in mid-August when a spell of exceptionally heavy rain prevented my entering the Honey-buzzard hide I heard two Hawk-eagles, a female and a recently fledged juvenile, calling to each other during short lulls in the rain.

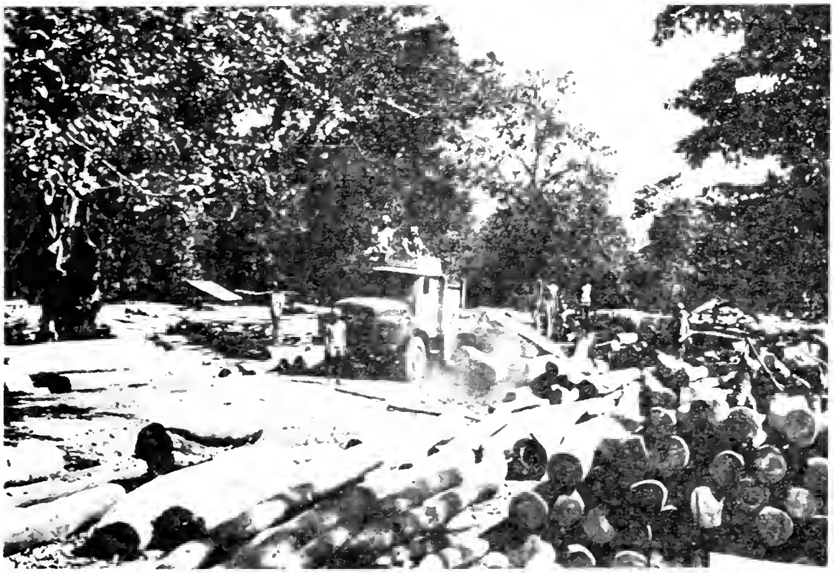
Food and Hunting

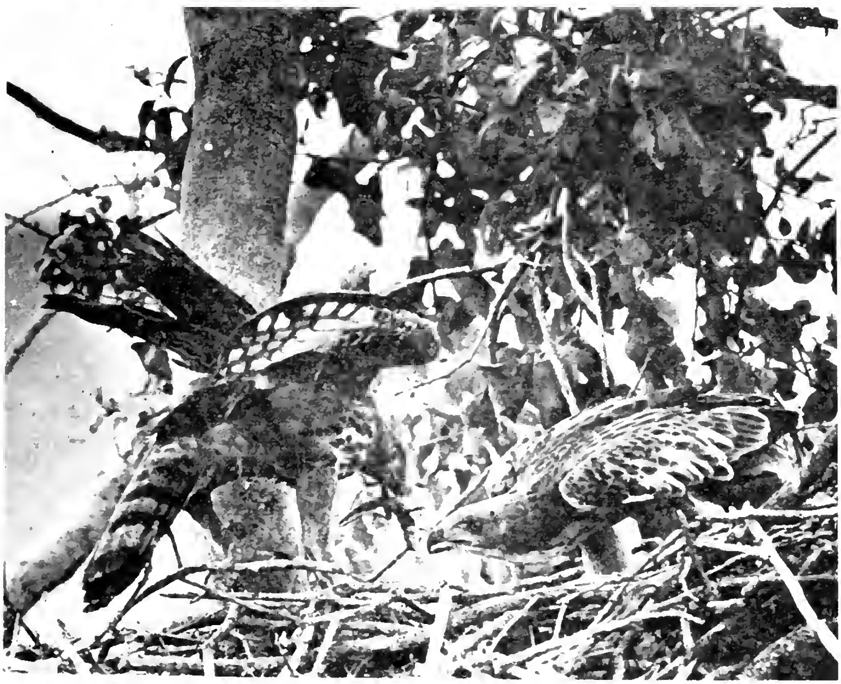
The following prey species were found in the nests of Hawk-eagles and also observed being brought to the nest:

(1) Indian Chameleon (*Chamaeleon zeylanicus*); (2) Common Garden Lizard (*Calotes versicolor*); (3) Other lizards — unidentified; (4) Common Myna (*Acridotheres tristis*); (5) Parakeet (*Psittacula* sp.); (6) Bush Rat (*Golunda ellioti*); (7) A small foot long worm like snake locally known as 'Iller'. Unfortunately no specimen was obtainable and the nest No. 1 male was seen flying with this prey in his talons; (8) Unidentified mantled game bird, the size of a small chicken; (9) One feed consisted of an unidentified rodent. The prey was brought headless to the nest, the body being dirty grey, in shape resembling a rodent's as did the intact legs. The tail 3/4 inches long and also dirty grey was very hairy like a bottle brush but not so thick; (10) Palm squirrels (*Funambulus* sp.) — many a times found wholly in nests 2 & 3 along with chameleons when the birds were incubating.

Calotes and chameleons however were the major prey species brought to nest No. 1.

Late afternoon on 6.v.83 the brooding ♀ was alerted when a loud rustling amongst the dried leaves was heard. The ♀ stood up as the sound continued from below. She suddenly swooped down to the ground directly from the nest, landing with an audible thud gripping a bush rat (*Golunda ellioti*) in her talons.





Above: One of the many wood and charcoal depots around Rajpipla spelling doom for the only remaining salvagable patch of forest between Uppla Junna Raj., Namgir, Piplod and Kokum villages. Senseless exploitation in all its forms continues unabated resulting in the outer forest on the peripheri of the range near habitation being irrevocably destroyed. At the present rate of abuse the remaining forest should soon disappear within a few years. (*Photo* : Sunjoy Monga)

Below : *Spizaetus cirrhatus* — Male at nest with prey. Note begging posture of young. (*Photo* : Author)

Above : Spizaetus cirrhatus — Both adults at nest. Male is just leaving after having brought prey to the nest. He is lighter in colour.

Below : Spizaetus cirrhatus — Female alighting at the nest with a lizard.

(*Photos*: Author)

She stood thus, her talons embedded in her prey till all struggles ceased. She then flew to a nearby tree and arrived at the nest 15-20 minutes later to feed. This was the only time that a natural killing was observed.

The ♀ was far bolder than the male and when induced to kill live bait in the form of chickens she readily took them, sometimes within 20 minutes of the bait being tied. Twelve baits in all were offered 20 metres from the nest. As seen from the diagram (Fig. 3) the baits were killed from all possible angles. Sometimes she would swoop down in a beautifully long low angled dive. On other occasions

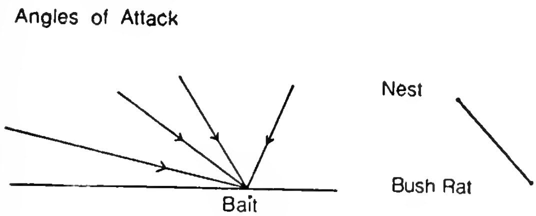


Fig. 3.

her final attack would be from a short distance away from a height, thus attacking from a very acute angle. She would observe our arrival and circle above us expectantly. While the bait was being tied she would perch nearby waiting fearlessly. On some occasions she would be perched far away and after the bait was secured would fly and perch almost above it sometimes for upto 40 minutes and then dropping down she would unerringly grip the prey at the end of her swoop sometimes catching it off the ground as it leapt up in its last moments to escape. Occasionally the prey would be caught with the talons of both feet in its back at high speed, both prey and eagle hurtling forward with the momentum until they were stopped by the leash, securing the bait. Subsequent examination of the bait showed a deep gash on the back. Should the prey struggle making it difficult to subdue she would slash their necks with her beak and change her grip to the nape leaving the other foot anchored deep in the body.

Initially prey were tied to heavy stones and twice she showed her great strength by trying to fly off with baits tied to a 4/5 kg. stone, dragging them on one occasion actually 15 ft. on a downward slope and on the other 8 ft. in one great burst of energy. She would also tug at the prey with her beak like a dog worrying a piece of tied meat landing exhausted on her back in her efforts to free the prey. Giving up temporarily she would begin mantling, later trying to tug it free again. This proving ineffective she would eat her fill on the spot, subsequently tearing the prey at the leg joint taking with her the upper half, leaving the legs intact still attached to each other and the stone. Due to her frenzied efforts to free the baits they would become quite shapeless and unrecognizable. The young however was fed from these kills only twice. Before actual mantling began the baits were usually beheaded and scalped, all the flesh from the head being eaten exposing the skull. Sometimes the eyes were first torn out and eaten. At all these induced kills I have found skulls beside the feathers and uneaten remains. Depluming now follows, the feathers from the legs and lower abdomen first being plucked, and later, the breast feathers. When the abdomen is free of feathers she splits open the lower abdomen between the legs using her beak like a surgeon's scalpel. She initially begins feeding on internal organs like the liver, kidneys etc. The wings feathers are then plucked. Much of the intestines are left with only a few choice lengths being swallowed. Slivers of meat from the neck are also neatly sliced and eaten while portions of the neck are sometimes swallowed. Feeding usually

lasted about 45 minutes. If the ♀ was still hungry as she was on some occasions, portions from the breast, back and rump would also be eaten. Usually after the inhards and part of the breast are devoured the rest is carried off or remains uneaten. She twice gorged herself hungrily oblivious of everything but the urge to eat. After such feeds her bulging crop resembled a pouch and her beak and forehead were spattered with blood. With a full crop she would waddle like a duck swaying from side to side as she walked around the kill, before flying away heavily to perch close by still showing an interest in the remains.

When small prey which appear to be their normal diet are killed (Calotes, Chamaeleons and the occasional squirrels and bush rats) nothing is wasted and the whole prey consumed. Though their normal prey are small in size *Spizaetus cirrhatus* are competently capable of killing larger prey. Domestic hens and cocks upto 2 kgs. were easily taken unhesitatingly with great alacrity. There are records of *Spizaetus cirrhatus* sometimes taking a peahen. Trained mountain Hawk eagles (*Spizaetus nipalensis*) have been flown successfully at *Bubo bengalensis* and have been known to kill larger prey in the wild state. I have observed the closely related Bonellis *Hieraaetus fasciatus* about the same size as *Spizaetus cirrhatus* bring monitors *Varanus* (2½ to 3 ft. long) to the nest along with partridge and spurfowl. After observing the ♀ feeding on large baited prey it became apparent that the stomach contents and breast of a medium sized hen is usually more than enough to satisfy a large adult. After satiating herself the ♀ would tear off the upper part of the body and fly away storing the remains for later consumption. The legs being tied were left intact on the ground as too much effort was required to free them.

On one occasion just after the ♀ had delivered the coup de grace to a small hen the ♂ dropped a calotes in the nest. The ♀ looked skywards and after inspecting the nest returned quickly to the bait silently except for the sound of her wings fanning the dried leaves as she landed. She then left shortly afterwards disturbed by village cattle that had grazed too close for comfort leaving the dead bait on the ground which was placed in the nest. She ate substantially without feeding the young flying off with the remains. It was noticed that the male would hunt further afield while the female nearer the nest. On two occasions the male was observed hunting one and half to three kilometres away from the nest. On one of these occasions he was spotted with a freshly caught calotes in his talons, flying from the ground to a tree.

Spizaetus cirrhatus do appear to have a preference for a varied assortment of small sized prey. The fact that they successfully prey on mynas and parakeets prove that they can be very agile[3]. The only ground birds seen hunted however were nearby village poultry. There is no doubt that Hawk eagles do take every opportunity to attack domestic hens during their breeding season but these opportunities do not come often and attacks are rarely successful. I myself have seen one such determined but unsuccessful attack. The commotion of desperate cackles emitted from about 12 to 15 hens running for their lives once drew my attention and a Hawk eagle was seen rising on the wing from the end of its near successful stoop. The Rajpipla forests being disturbed and

[3] In April 1985 I observed a ♀ swoop from her nest in a Mohwa (*Madhuca indica*) tree into a flock of feeding Redvented Bulbuls neatly catching one which she feathered in a neat pile on the spot before flying to the nest (Fig. 4).

degraded, affords little if any cover for game birds. Has *Spizaetus cirrhatus* adjusted to this deteriorated environment by almost solely living off smaller prey which they are also very adept at catching? It would however economise energy to kill larger prey which they probably would with reasonable ease given the opportunity. An undisturbed study area with a balanced prey population might reveal a true percentage between large and small natural kills. Could prey preferences change during the breeding season? If the adult's preference is for large prey in a balanced environment, they could gorge themselves going without food till the next easy availing opportunity without expending energy daily. The young however

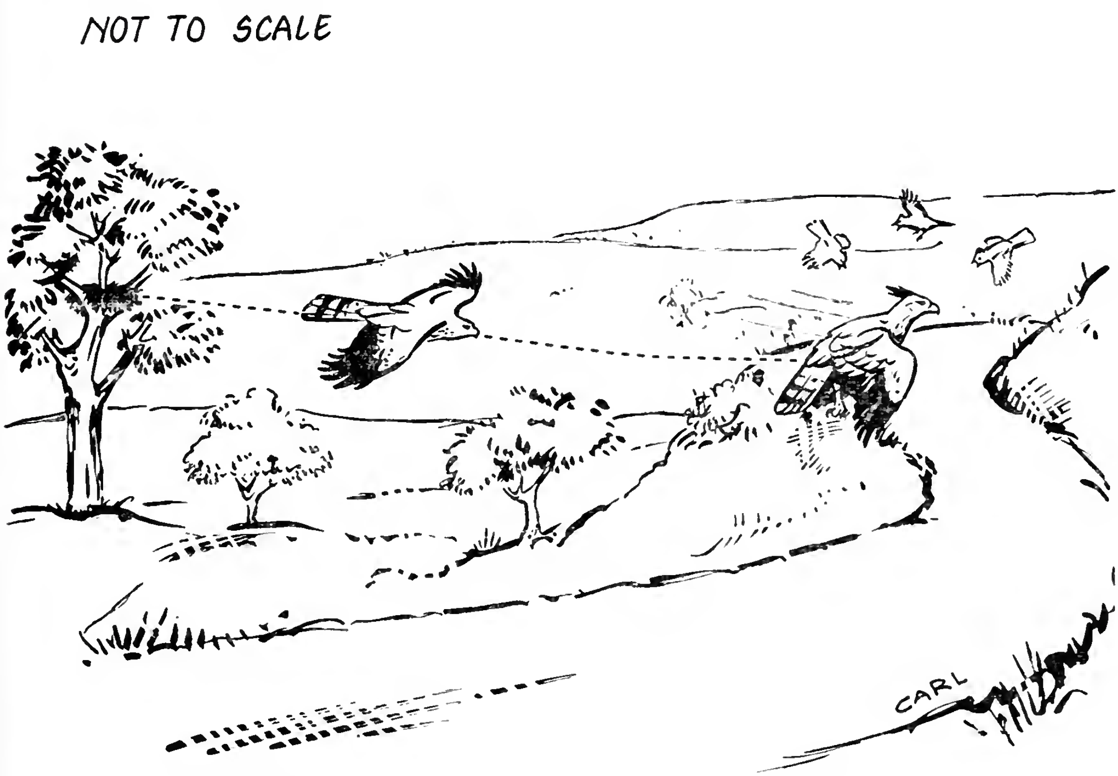


Fig. 4. The figure shows the second attack witnessed directly from the nest in 1985. In 1983 a bush rat was similarly taken though the angle of attack was much more acute. The ♀ in this case flew directly from the nest which commanded a wide view into a flock of feeding unsuspecting redvented bulbuls on the Ghat road from Rajpipla town to Junna Rajpipla village. She caught a young bird that was moulting (feathers retrieved positively indicate a moulting juvenile) and leaving the plucked feathers neatly in a pile by the side of the road she flew back to the nest mobbed continuously by the bulbuls. The nest tree was the highest and largest in the area, the surrounding forest having been cleared the Mohwa tree has survived because its flowers once fermented provide the adivasis with their favourite home made intoxicant. The ♀ was observed between 8 a.m. - 9.30 a.m. to pluck green sprays from the nearby stunted trees.

needing a daily food supply could be causing a change to smaller prey which are easily caught in numbers.

Voice & Calls, and General Behaviour of Adults at the Nest

Male/female identification was made by size differentiations when both birds were at the nest and by certain physical characteristics and behaviour.

The ♀ was larger, dumpier and darker in colour. She displayed a self-assured demeanor lacking in the much shyer male especially at the nest. The ♂ was slimmer, lighter in colour and more dashing in flight. The ♀ could positively be identified by a white patch at the base of her crest.

Brief Description of the Female

White breast — (extending from lower neck to abdomen) with dark brown vertical streaks, each streak being dark brown down the centre and lighter towards the edges. Eyes bright yellow and crest (consisting of about six large and four smaller dark brown to black feathers tipped with white) on crown horizontal to the head. Head brown with thin black horizontal streaks. Rest of the plumage uniformly brown. Beak and lores black. Underside of primaries white tipped with dark brown with thickish uneven brown bands running horizontally across each feather. Tarsus light brown. Tail extends well beyond primaries and underside is black tipped with 2 white bands separated by a very thin black band. The upper tail feathers are brown with 4 thick very dark brown bands across them. From a head on view a faint facial disc is discernible which is darker than the surrounding brown of the head.

An unusual occurrence or a disturbance or threat to the nest would trigger of a response from the ♂ who would then join the ♀ at the nest (e.g. a climber climbing up a nest-tree for the first time) as if to re-assure himself that all was in order. The ♂ would do all the hunting and would when incubation was under way remain near the nest for long periods when not away hunting. When the young had hatched and until it was about 6 weeks old the ♂ did almost all the hunting. The ♀ spent most of the time brooding and remaining perched nearby. Impatience at the ♂'s arrival would be voiced by the ♀ as she occasionally glanced skywards. The ♂ would often bring prey sometimes half eaten directly to the nest, heralded and beckoned by frenzied, urgent calls and shrieks of different intensity, volume and notes from the ♀. L. Brown observed that males of African Hawk-eagles tend to come more readily to the nest than other species. I found this true with *Spizaetus cirrhatus.* On other occasions prey would be brought by the ♂ near the nest and the female would fly out and join him. Sometimes losing patience the ♀ would call beckoningly and fly out to meet the ♂. Prey would be brought a few minutes later by the ♀ to the nest. As the young progressively matured, and brooding correspondingly lessened the ♀ would venture out to hunt in the general vicinity of the nest but not too far so that she could guard the nest and fly back post haste if danger threatened, though the ♂ continued to do most of the hunting. Communication through calls played a very important role in strengthening the pair bond between ♂ and ♀ and when performing ritualistic behaviour. Calls varied from the normal 6 to 7 notes upto even 12 and 14 with varying pitch and tone depending to what extent the ♀ was impatient or agitated, her urgency represented by additional notes. A few instances of behaviour and resulting vocalising of varied intensity are noteworthy.

Above : Spizaetus cirrhatus — Portrait of a fully-fledged young.
Below : Female *Spizaetus cirrhatus* on nest-tree.
(*Photos* : Author)

Above : Spizaetus cirrhatus — Female on a freshly killed bait.

Below : Spilornis cheela — Young giving threat display. Note the well formed crest.

(*Photos* : Author)

9.30 *a.m.* Late morning and ♀ is brooding. Alarm calls heard and ♀ calls twice, then a 7 note and subsequently an impatient 8 note call there being a direct relation between no. of notes and urgent impatience or eagerness. ♀ calls again 10.49 *a.m.* ♀ leaves nest and perches on a nest supporting branch overlooking the valley. 11 *a.m.* ♀ flies off calling. 11.35 *a.m.* ♀ arrives without prey and calls continuously 7 notes, 5 notes and 3 note calls. Then some single note calls followed by 7 note calls. She is excited and doesn't settle on the nest moving from one side to the other following the male's movements and calling continuously. 11.48 *a.m.* Male arrives with prey and leaves immediately. After the feed ♀ perches on nest supporting branch and returning to the nest rubs beaks with the young. Later during the day the male arrives again with prey but the female vocalizes passively.

12.18 *p.m.* Early afternoon — Brooding female calls. Later 5 notes then six, seven, eight and a nine note calls made summoning the male. She moved to her look-out perch 3 ft. away from nest. Till 12.44 *p.m.* she called but instead of screaming the calls she shrieked them out the last notes extremely high-pitched, piercing and frenzied. 12.44 *p.m.* Male brought a chameleon.

8.43 *a.m.* Early morning and nest occupied only by young. Alarm calls. Four eagles seen and heard. Male circling over the valley. Female calls in anticipation. The whole valley now flooded with alarm calls as female calls louder, her calls high-pitched with last notes excitedly accentuated. 8.54 *a.m.* Female circles and glides over valley calling, her wings in line with her body, adjusting to the wind by slightly raising wings for a few seconds without a flap. She then flies over hide and nest and alights opposite the nest. No calls heard now. Later heard calling and seen circling over the valley and above her the male, buoyant in flight but not as much as *S. cheela.* 9.54 *a.m.* Female arrives with a chameleon. Later the same day 11.54 *a.m.* female leaves nest after scanning the valley. Calls occasionally and then in quick succession rising to a crescendo. Alarm calls. She then flies low over the nest (two and a half feet) and utters the most hideous shrieks. 1.04 *p.m.* Female arrives with a chameleon. On this occasion and a previous one when chameleons were brought to the nest the intestines (black in colour) were eaten by the female.

10.24 *a.m.* Female leaves nest when I enter the hide. 11.50 *a.m.* calls heard. Till then there was silence. 12.24 *p.m.* Female calls urgently from her perch. Male arrives and the two give vent to high-pitched shrieks. The young's metallic calls can also be heard. The adults vocalize differently. The male "Klee Klek" and "Klee kee kee Keee Kee Kee Kleee" by the female. 12.31 *p.m.* ♀ arrives with prey. Later the same day when the young was 33 days the female at 2.25 *p.m.* silently arrived at the nest after an hour's absence with a chameleon which she probably caught herself. No calls were heard and she was seen circling opposite the nest tree before coming into land. On other days the young would be alone in the nest, the male's visits with prey heralded by vocal female perched nearby. For four hours with the remains of the hen and calotes in the nest, the female accompanies the young but does not feed. The young is on one side of the nest and the female on the other. Later the same day an unusual incident occurred. The young had after four hours been fed on the hen. Female calling in falsetto flies off to meet the male. A few minutes later the male alights alone at the nest without prey. Female continues calling while he's at the nest.

2.52 *p.m.* Brooding ♀ calls frantically. Male

alights on a nearby tree where the female joins him. They interchange positions sideways from left to right, the ♀ trying to get at the prey whereupon the male flies to the ground leaving the prey. The female descends and carries the prey to a nearby perch from where she brings it to the nest at 3.03 p.m. The female (young now 36 days old) also being hungry eats substantially of the prey. Meat is torn with sideways twists of the head and fed in the manner of most raptors — held out at tip of beak close to beak of young which takes it at great speed.

When the young was in the downy stage the ♀ spent most of the time brooding. When away from the nest especially when the young was older and brooded less, the ♀ was often mobbed by crows and drongoes. For 4 continuous days the brooding ♀ was persistently mobbed at the nest at various intervals during each day by a brown shrike (*Lanius cristatus*). The shrike for these 4 days kept up a barrage of bombing raids, each sortie directed at the ♀'s nape and head and carried out with great speed, dexterity and persistence. Quite often audible contact was made. It became impossible for the ♀ to ignore these irritating attacks and she would follow its movements with gape wide open and duck every time the shrike attacked. Even when the ♀ was feeding on the bait on the ground the shrike suddenly appeared and mobbed her. It would keep up a continuous swearing, a harsh, metallic "ch-r-r ch-r-r ch-r-r". These attacks were always made from above, the shrike improvising on the direction of each sortie. On one occasion while these raids were being enthusiastically carried out a common drongo was seen perched above the nest, watching the proceedings with great interest but without taking part.

At the nest flies interfered with brooding. They would settle enmass on the eyelids of the young and female. It was noticed with Serpent eagles, Shikra and Honey-buzzards, that flies have a preference for the eyes of perched and brooding raptors. The ♀ would try to flick them off by blinking but they would soon be back and when they got too bothersome she would shake her head sideways vigorously 3 to 4 times.

All visits to the nest (6 in all observed) with green sprays were brought during the morning hours invariably between 8.30 *a.m.* and 9.45 *a.m.* On two occasions the ♀ was observed flying to some nearby trees 120 feet away from the nest returning with green sprays. These trees were, *Dalbergia latifolia, Diospyros melanoxylon, Hymenodictyon excelsum, Anogeissus latifolia, Aegle marmelos, Terminalia bellirica.* She would snip off stout twigs with great ease and while adjusting sticks in the nest she once broke off a protruding end of 4 inches with one quick fluent twist of her head.

When young was around 35 days old the ♀ started hunting a little on her own. As the female was also hunting sporadically though not regularly like the male, prey bringing visits to the nest sporadically increased. Definitely more kills were being made than had been earlier observed at the nest. The ♀'s own prey bringing visits were conspicuous by the absence of calls.

Most raptor calls were mimicked by drongos. On many occasions a genuine Hawk eagle call or series of calls would be followed by a convincing rendering by nearby drongos, almost an echo of the real calls. This was misleading at times and one tended to be very careful about verifying the origin of calls heard. Their mimicry was true to pitch but differed in volume intensity and number of notes. The ♀ herself was misleadingly alerted one day by these mimics.

Most of the prey brought to the nest was fed to the young, the female taking random mouthfuls not enough to sustain her through the day especially when she was brooding. The male too had to maintain a high metabolism for the energy required for hunting and keeping three birds alive. Many more kills were obviously made than what was actually brought to the nest. Only on two instances was the ♀ observed eating substantially from prey at the nest. Once the intestines of a chameleon and on another she ate substantially of a lizard while feeding the young. On three occasions she gorged herself on baits so that her crop resembled a pouch and her flight was exceptionally heavy and sluggish. During the early stages when the ♀ was almost continuously brooding and feeding the young, she was dependent only on the male for food and was probably fed away from the nest. Later when brooding progressively lessened after the first four to five weeks she hunted for both the young and herself, staying away from the nest for longer intervals but never straying away too far. On two occasions she killed near the nest 30-50 ft. away, — a bush rat and calotes.

When the young was four weeks old the ♀ just accompanied the fledgling at the nest, both birds two to three feet apart dwarfed by the huge nest. Feeds were now erratic and prey would not be fed immediately even with kills present in the nest.

When the young was around 52 days old about 3½ weeks before it became independent of the nest brooding had tapered off completely though on the odd day the young was briefly accompanied at the nest. Likewise with both *S. cheela* and *Spizaetus cirrhatus* it was noticed that even when fledged young were capable of feeding themselves (if rather clumsily) the females would still indulge in feeding their young occasionally. Both adults were now hunting regularly as no apparent danger threatened their fully grown eaglet. One day 2 km. away from the Hawk eagle nest I saw Buzzards (unidentified) and a pair of Shikras about 10 in all circling high overhead.

Some unusual calls were also heard. Once while feeding on the bait on the ground the ♂ flew over-head and the ♀ uttered 3 to 4 nasal snort like calls never heard before almost as if she were sneezing and at the nest she uttered 2 syllable calls increasing to 5 syllables. Both these calls were never heard again. Intensity of calls tapers off as brooding lessens and young matures. Prey is brought silently to the nest and visits are not ushered in by frenzied calling, though low-keyed calls are frequently heard.

One day a spectacular aerial display was performed when an assistant was climbing the nest-tree. Circling high up above the nest the female with folded wings dived repeatedly upto within a few feet of the climber. The wind passing through her feathers could be heard from the hide. She was then joined by the male who was by this time (4.vi.83) undergoing a moult. The male followed her closely till they were shortly joined by another Hawk eagle in semi-juvenile plumage also just beginning to moult. As mentioned earlier during machan building 3 adults were seen together near the nest. This third bird was followed closely by the female and it appeared to me that the female was gently but firmly escorting it away from the nest. They flew out of sight and while leaving the hide I saw the female perched alone nearby. On another occasion after feeding the young the female left the nest and joined two Hawk eagles across the valley where they finally flew into the trees on a ridge above the valley.

From nests where young were casualties, no

further breeding was observed and when checked a few weeks later they remained empty showing no potential signs of breeding like fresh leaf linings etc.

As we were baiting the ♀ regularly but sporadically, she would circle above us whenever we approached the nest checking in fact if there was going to be an opportunity to get an easy and filling meal in the form of live bait.

At around 58 days the young was being left alone at night though when exactly is not known. During the young's first flight the ♀ was perched nonchalantly 50 yds. away. She was mobbed and chased by crows as she changed her position causing the young to excitedly change position too. Though the ♀ gave no visible encouragement as it was probably not required, she could have enticed the young further away from the nest had she wanted to. This sort of encouragement was observed at a 1981 *S. cheela* nest at Sankri (see Journal Vol. 80 No. 2, August '83). Even with the young hopping among the branches calling inquiringly, there was no response from the adults. This prompted the young to fly towards the female when it for some apparent reason flew back to the nest. Prior to its arrival at the nest the female had been observed killing a calotes and eating it by herself. The young thinking a feed was in the offing flew back to the nest but later showed indifference after the ♀ had demolished the calotes. The young at 70 days was being largely left to its own devices. The female would on occasions still feed the young though this chore was executed at her own discretion now that the young could somewhat feed itself. This capitalizing on the young's hunger would accelerate the young's independence to feed itself. The ♂ was never observed actually to feed. During the eaglet's last days at the nest the female arrived with a lizard at 5.09 p.m. Begging gestures of the young were ignored and she joined the ♂ flying above the valley at nest level. The ♀ later perched for an hour in the valley below visible in silhouette called twice. The young desperately hungry turned its attention to the prey instead of waiting fruitlessly for the female. It managed with some intial difficulty to tear up the prey eating competently till 6.05 p.m., taking only 12 minutes to completely demolish the lizard, a prime example of how the female reacted with her fully-fledged young. Seven days later the ♀ was observed feeding the young four days before it finally became independent of the nest on 28.vi.83. In early July, I visited the nest-site and the ♀ conditioned to our arrivals with bait circled overhead expectantly. The nest was empty.

By 17.viii.83 while *S. cheela* young had all flown with immatures occasionally spotted, the Honey-buzzards were rearing their almost fledged young. On that day a ♀ Hawk-eagle and juvenile were spotted perched silently and motionless in heavy rain opposite old Mozda village just off the main road near the river about 3 kms. from nest No. 1. During two short lulls the juvenile would call eagerly the ♀ vocally reciprocating, joining the young twice before finally flying off to perch 50 metres away. Both juvenile and the ♀ were about the same size. The juvenile was constantly mobbed by a lone crow and the ♀ looked magnificent as she perched near the juvenile, spreading her wings to dry after a heavy shower. The young appeared to be hungry and still dependent on the ♀. This juvenile could have been the offspring of nest No. 1 but until these birds are ringed and their movements plotted it will be impossible to answer many intriguing and perplexing questions.

Spilornis cheela Crested Serpent Eagle

Courtship

Some Serpent eagle displays were observed while watching an incubating Hawk-eagle. On most occasions pairing off of *S. cheela* involved three birds participating, 2 more actively than the third. Displaying Serpent eagles are extremely vocal and being densely populated and so common their calls were heard throughout the area. Their courtship display consisted of frantic vocalizing by a pair soaring and circling high overhead. Usually a third adult would be circling on its own some distance away or perched nearby also vocalizing. Sometimes a pair would circle, one slightly above the other, the higher bird suddenly breaking off and soaring away over a hill resuming circling, all the while closely followed by its partner. Sometimes three Serpent eagles would be seen circling together and often flying over a Hawk-eagle's nest. Both species tolerated and nested in close proximity to each other. The Serpent eagles aerial ballet display is beautiful to watch. They glide circling in slow motion, sometimes flying very low and slowly calling continuously. The wings are held exceptionally high forming a sharp V and due to slow flying the birds have to occasionally flap their wings to regain momentum after stalling (Fig. 2). They circle round thus following each other until one turns around crossing the other but maintaining the concentricity of the circle. One morning after thus displaying a pair settled on different trees calling to each other. A third eagle was observed perched nearby. A few minutes later one of the pair joined the other on the tree and perched above it. The lower bird took five minutes hopping with wings flapping to reach the top, calling excitedly all the time. When the bird eventually reached the same height it made a move towards its beau which flew off. It immediately followed and they re-circled and vocalized as before with wings held well back. They then disappeared following the third eagle which had already flown in that direction. On another occasion two adults were seen soaring above nest No. 2 of the Hawk eagle 2½ km. apart. Their vocalizing first drew my attention and I am now quite convinced that vocalizations play an important role during the Serpent eagle's courtship display. These two birds interacted through vocalizations while a third perched nearby answered with long drawn out one note screams and whistles "Phweeee" and "Keeu". Later one of the circling pair was answered for a few minutes only by the perched adult and not the circling partner. The circling pair flew in circles rising higher and higher calling out to each other. They then circled in opposite

Nest specifications

Table 2a

Nest No.	Nesting Tree Species	Height of the nest from the ground	Inside diameter	Outside diameter	Depth
1	*Dalbergia latifolia*	14.7 Mtr	26.6 cms	67.5 cms	11.9 cms
2	*Dalbergia paniculata*	12.3 „	24.1 „	50 „	15.2 „
3	*Elaeodendron roxburghii*	15.3 „	21.5 „	55.8 „	13.9 „
4	*Bridelia retusa*	17.4 „	24.1 „	62.7 „	16.5 „
5	*Lagerstroemia lanceolata*	16.2 „	29.7 „	61.4 „	22 „

directions maintaining the circle and when the lower bird (the ♀) passed close under the ♂ it flipped over performing a complete somersault, its talons outstretched towards the ♂ who, however, veered away just when it appeared their talons would lock. Flipping over was observed twice in about 10 minutes. No actual contact was made but both the birds were very close to each other.

Nests and Eggs

As seen in table No. 2a, the nest trees in '83 consisted of many species but *Terminalia crenulata*. Yet in 1982 most nests found were on Sadar (*Terminalia crenulata*). Nests are lower than those of the Hawk-eagles and much smaller. Some nests were so small that the tail of the incubating ♀ could be clearly seen projecting out of the nest. These small untidy nests resembled a crow's but larger. The general habitat was dry deciduous interspersed with Bamboo and Strobilanthes, and nests were usually better concealed than the Hawk-eagle's. Oval nests were situated generally facing East to West on convenient forks three-fourths up the tree to the top most suitable crotch. The nest trees are usually bare at this time when these eagles are incubating. Coinciding with their early-nesting period the outbreak of the monsoon ensures a thick leafy canopy around the nests. Nest lining in two nests contained leafy sprays of the same species as the nest-tree. Whether they were taken from the nearby vicinity or from the nest tree itself is not known.

The eggs are large (Table 2b) and oval in shape, normally broad and narrow at either ends. Some eggs are exceptions with both ends similar in shape and size. They are white with variations of rusty-red blotches, sometimes just speckled with red spots and rarely, a large blotch of red restricted solely to the broad end.

Table 2b

Egg measurements

Sp'lornis cheela

Nest No.	Length (mm)	Max. diameter (mm)	Weight (gms)
(1)	62.78	51.38	94.5
(2)	71.40	53.54	110
(3)	65.42	53.30	100
(4)	68.72	55.5	112.5

From: Baker's Nidification.
61 eggs averaged 71.8 × 56.2 mm.
Maxima 77.3 × 57.6 mm.
Minima 66.3 × 52.7 mm.

Incubation

The first nest of *S. cheela* was found on 6.iv.83, the ♀ observed incubating. While the Hawk-eagles were rearing young, the Serpent eagles were incubating. After an egg was destroyed the ♀ was observed sitting in the nest for a few days during the early morning hours. This nest was never re-used though the pair may have nested elsewhere. Displays at this stage were frequently seen sometimes directly over the nesting area.

Growth of Nestling

A one day old young of *S. cheela* weighed 65 gms. Its tarsus was pale yellow, lores black with thick black distinct eyebrows near the lores. Faint yellow streak running down bare belly. Head, Body and Wings pure downy white. Mouth pale yellow to grey, eyes blue black, bill black with egg tooth visible and claws light brown. Both ear-holes black. An approximately three week old young from another nest weighed 310 gms. It lores were blackish green, covered throughout densely in

down. Feather growth just emerging on crown and wings. Primaries emerging but white in colour. Through down on back two faint parallel feather lines emerging on either side of vertebral column. Mouth pink tinged with greyish black, bill black, eyes grey, pupils blue, tarsus yellow green, claws greyish brown, gape and cere green.

Some fledglings reacted more aggressively than others. A 3-week old *S. cheela* young gave a convincing threat display when handled. The Hawk-eagle young at the same age was relatively docile. A perky 14 days old Honey-buzzard young gave a typical threat display spreading its stumpy wings following the climber's every movement ready to peck.

Behaviour of a fully-fledged young

In early July, *S. cheela* young are almost fully fledged some whose tails, however, are just beginning to emerge beyond their primaries. Observations on the Mozda nest showed that while the young's crest was well developed the ♀'s was missing. Could this be the beginning of a moult? Her plumage was otherwise perfect. The young was capable of locating and feeding from a tear made in a carcass by an adult. Once fleshy parts were exposed the young easily fed on the innards and tore off and swallowed large chunks of meat. Snakes when not sometimes swallowed required a tear in the body to initiate feeding. The ♀'s help was required to pass snakes from beak to beak into head first swallowing position, otherwise snakes would lie uneaten in the nest. A snake would be dropped into the nest, the ♀ returning later to offer it to the young. Young once swallowed in great gulps the complete lower half of a *Rana* including both feet in just a minute. This last mouthful was large even for an experienced adult. Two to three visits to the nest were made only by the ♀ and after dropping prey into the nest she would immediately depart. Both adults were now regularly hunting along the banks of the Mozda river $1\frac{1}{2}$ kms. away from the nest. This nest was the smallest observed. When the ♀ visited the nest she perched on the rim at a very odd angle as the fully grown young fully took up all available space. Towards the middle of July a few days before the young would finally fly off, the flattened dilapidated nest was sloping from the left to the right appearing to almost slide off the supporting crotch. Its general behaviour was similar to all young fledged raptors giving effective threat displays, spending long hours standing, preening back, breast, primary feathers and dozing, its chin resting on the nest-rim. Heavy rain did not bother it while gusts of wind were utilized for exercising wings. The young unusually quiet would emit shrill, loud, long drawn out, one note screams on seeing the adults with prey adopting a crouched begging posture and continuing calling after a visit. Defecation followed feeds and it would sometimes stand resting on its right leg, the left leg bent and supported at the tarsus/tibia joint on the nest-rim. When danger threatened, it would like all raptor young sit close on the nest almost merging with it. Even though young could feed itself it was sometimes fed by the ♀. A *Rana* was eaten wholly by the young but later the same day a bush rat was fed by the ♀.

Description of fully-fledged young in nest as on 19.7.83.

Tail stumpy on 1.vii.83 and slightly protruding beyond the primaries. Crest dark brown and white tipped appeared well-developed merging with the mottled head. Base of mottled head feathers was pure white. When the wind ruffled up the white-tipped brown head feathers

they stood out, stuck as they appeared into the pure white crown. Lores were greyish yellow, eyes yellow and bill black. Upper parts dark brown with feathers tipped white along the curve. Underparts light brown with white spotted designs on breast, belly and tibia typical of the species though still faint and scattered. Tibia feathered and very light brown. Tarsus dull yellow (Plate 5).

1.vii.83 Underside of secondaries and primaries whitish. 19.vii.83 underside of primaries have broad white horizontal bands with narrower alternating dark brown bands on either side.

All available references on immature plumages describe synonymously only the juveniles of the nominate race *S. cheela cheela.* These descriptions which suit the specimens of the nominate immatures in the B.N.H.S collection differ considerably in appearance from the fully-fledged young of *Spilornis cheela* observed over two seasons in the Rajpipla forests. Geographically these birds come within the range of the Southern race *melanotis* (see *Journal* Vol. 80 No. 2). In brief the nominate immatures have a mottled white and brown upperside ,the underside being pure white with dark brown vertical streaks mainly on the breast (Plate 5). Tails of all the juvenile specimens are well developed indicating that they had most probably been collected after being nest-independent but well within the first year. The only similarity between the descriptions of the nominate immatures and the Rajpipla young observed are the mottled heads. Another immature seen by me in Rajpipla out of the nest after the nesting season was also uniformly brown, upperside however darker than the underside as in the adults, the head being somewhat mottled. A previous year's young also fitted this description (*Journal* Vol. 80 No. 2).

This is thus only an interesting pointer towards differences in plumage among immature Serpent eagles though far more substantial evidence is required as to whether this difference in plumage is consistent between the races. In the light of there being no adequate description of immature *Spilornis cheela melanotis* in reference literature, the above observation appears to be of interest.

Food and Hunting

Prey preferences of *Spilornis cheela* change at the outset of the monsoon in mid-June. The young would by now be about a month and a half old in early July and the variety of snakes caught earlier during the dry season (see *Journal* Vol. 80 No. 2, August 1983) is now mainly restricted to checkered keelbacks (*Xenochrophis piscator*) of all sizes along with the occasional rat snake. At this time *Xenochrophis piscator* are probably the easiest snakes to spot and capture. Each day the Mozda pair (first the male during the early brooding sessions and later also the female) were seen perched along the banks of the nearby river only three quarters of a mile away from the nest. One day an adult was seen descending from its perch and disappearing from view below the high bank of the river. Ten minutes later it was seen rising with a snake in its talons. In 1982 a pair (possibly the same) nesting nearby were seen with a snake at almost the same spot. The Indian bull frog (*Rana tigerina*), the Bush rat (*Golunda ellioti*) and other lizards mainly calotes figure to a lesser extent in the diet of these birds.

Voice & Calls and General behaviour at Nest

The Serpent eagles are very vocal and active during their incubation stage. Once while watching an incubating pair soaring I saw a third stoop down at great speed upto them, all

three then circled screaming to each other. The pair then flew away together while the third flew in the opposite direction. On two occasions, two birds were seen calling excitedly to each other but each went their own opposite ways.

By end June Hawk eagles have completed nesting and the monsoon has set in. The Serpent eagle nesting season is in full swing and they continue being very vocal at the nest and while displaying. All eggs hatched by middle to end May, latest early June, while the Honey-buzzards were still incubating, their eggs hatching around end June or later.

Territorial displays of *S. cheela* sometimes involved four adults (2 pairs) who settled matters by what appeared to be mainly vocalising. These vocal disputes occur just before and during the nesting season where two occupied nests are in close proximity to each other. Sometimes 2 pairs were seen vocalising and pairing off to their different territories after settling the matter by circling and vocalising. No physical contact was ever observed. On other occasions two birds (a pair) would be observed vocalising and soaring high above an active nesting area, also a sure indication of an occupied nest. Sometimes a third and fourth bird would appear. They would soar, circle and vocalise, then separate in pairs, e.g. one pair to their nesting area to the left of a hill and the other to the right where they each had a nest.

Pernis ptilorhyncus Crested Honey Buzzard

Courtship

At about mid-April to May, Honey-buzzards perform their mating displays. These thrilling displays involved deep undulations, much deeper than that of the Accipiters. First a downward swoop of great speed, flattening out and with the momentum rising, finally flapping the wings vigorously actually hovering at the apex of the ascent for a few seconds. This would be repeated over and over again with variations until the birds would fly out of sight. By this time they have finished repairing old nests or building new ones and though they haven't begun to lay as yet, the lining of green twigs in otherwise empty nests indicate that they would be laying soon. One such empty but lined nest was found on 30.iv.83 at Sankri when the nest-tree *Diospyros melanoxylon* was totally bare and the nest clearly visible. Its future potential was realised due to fresh green leaf linings present in the empty nest. Checking later on 8.vi.83 the tree had a luxuriant growth of foliage the nest being completely hidden. It contained two eggs smaller in size than those of *S. cheela* and *Spizaetus cirrhatus.* When again inspected on 21.vi.83 two fledglings were found in the nest.

Nests & Eggs

Honey-buzzard nests were found on the following trees: Timuru (*Diospyros melanoxylon*); Teak (*Tectona grandis*); Sheeshum (*Dalbergia latifolia*); Bedo (*Terminalia bellirica*).

Though Inglis and Blewitt found nests 15 ft. up in a Mango tree and 16 ft. up in a Sheeshum, all nests located were much higher. Coltart took 2 eggs from an old Kite's nest and one pair usurped the nest of a Shikra. At Namgir a 1983 Honey-buzzard nest 45 ft. high with 2 eggs had been a previous year's 1982 crow's nest. The nest had however since been enlarged by the Honey-buzzards.

All active nests of Honey buzzards were well concealed by monsoon foliage and were located half way to 3/4s up the nesting trees on suitable forks formed by three boughs. Nest No. 2 at Sankri facing NW-SE was 16½ metres high. Its specifications — 79 cms. outside dia-

meter, 30 cms. inside diameter, 12 cms. depth. Two egg were found. The first weighed $52\frac{1}{2}$ gms., Length 54.02 mm, Max. Dia. 44.26 mm. Second weighed 53 gms., Length 53.18 mm, Max. dia. 44.92 mm.

The second egg was literally splashed with rust brown, darker at the broad end.

The specifications of the two eggs measure up closely to Baker's average.

Incubation

During incubation Honey-buzzards sit tightly on the nest flying off reluctantly when a climber is more than half way up the nest tree. The first time the tree was climbed on 8.vi.83 the ♀ refused to bulge till the adivasi almost reached the nest. She circled above us calling "pheeuw pheeuw" then settled nearby watching us anxiously till we departed.

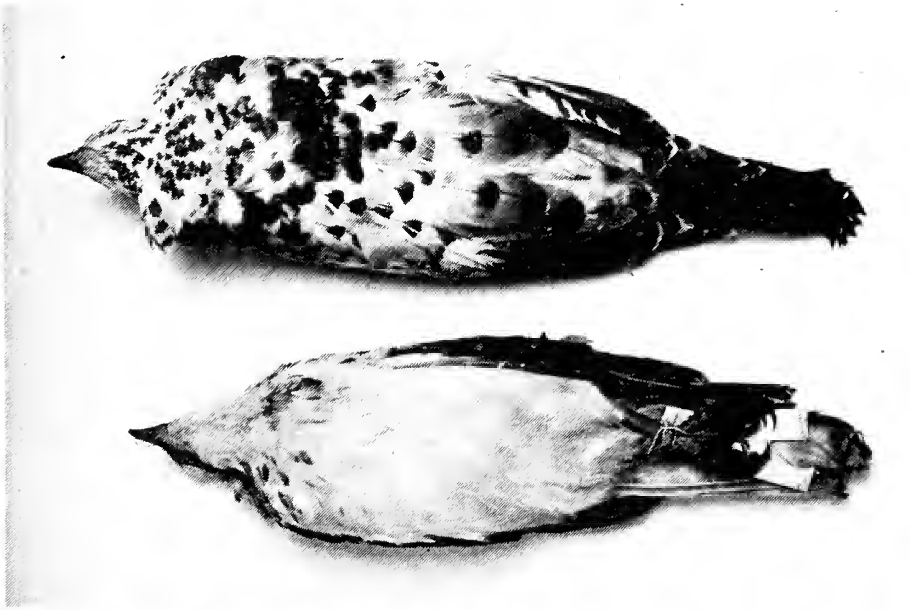
Growth of Nestling

Honey-buzzard eggs hatch, towards the middle of June, the young reminiscent of 4-6 day old domestic chicks. Though both eggs usually hatch only one young generally attains maturity. Out of 4 nests inspected, one at Sankri and three at Singloti, only one young survived. Two nests, one at Sankri and the other at Singloti had two young, but when later observed they were found to contain only one nestling each. At a Singloti nest where the weaker and smaller sibling died the body was left in the nest cavity for 3 days attracting numerous blue-bottle flies. The surviving fledgling about $4\frac{1}{2}$ weeks old perched near the nest rim to avoid the flies.

Honey-buzzard young though covered with down are not pure white like other downy raptors. Head being light brown with body light brownish white. Beak black and gape yellowish white. Base of beak yellowish white. Tarsus yellow.

Throughout the nesting season it was observed that Honey-buzzard young defecate minimally especially during the initial nesting stages. Unlike other raptor young like Shikras, Serpent eagles and Hawk-eagles, Honey-buzzard young defecate into the nest either on the rim or into the nest cavity. This was consistently observed. One unlikely sleeping posture was observed in a 20 day old young. While sitting the young turned its head around (facing rump) and resting its chin on its back fell asleep. Young keep up a continuous "cheep cheeeep" during feeding. A wet and bedraggled young was observed being preened by the ♀, after a heavy downpour. The ♀ preened the fledgling's crown as it slept after a feed, later changing her position to preen its rump. Brooding involved standing over the young as in the case of Hawk-eagles and not by lightly sitting on their offspring like Shikras and Serpent eagles. A severe bout of malaria ended all observations on the initial development stages of Honey-buzzard young.

Observations on the Honey-buzzards continued from 28.vii.83 onwards during their secondary nesting stage. The rains had by now set in without letting up for days. Feeds were erratic and no visits to the nest were observed during rainy spells. When an adult's visit was imminent the young adopted a submissive posture hunched up like a vulture, crouched with head and neck craned forward, turning around to keep the adult in view, its calls increasing in tempo and pitch finally ending with a crescendo and wing flapping just before and during the actual arrival at the nest. Even after prey was deposited in the nest and the adult departed, its calls would continue for many seconds before it settled down to feed. Chameleons were always passed head-on for swallowing easily. The young continued to defecate only into the nest-cavity until it was



Above: *Spilornis cheela* — Specimens of fully-fledged juveniles nominate race.
Below: *Spilornis cheela* — Fully-fledged juvenile southern race at the nest.
(*Photos*: Author)

Above : Honey-buzzard — Young displaying a frenzied show of activity.

Below : Honey-buzzard — A feed.

(*Photos* : Author)

independent of the nest by squatting with rump directly over nest-cavity or nest-rim, and defecating straight down perpendicularly. Occasionally excited due to an adult's imminent visit the young adopted various contortions of the neck first craning its neck forward and then backward towards its breast in an extended or elongated swallowing motion. Anticipating a feed the excited young would involuntarily defecate occasionally into the nest.

Description of Young — Secondary Stage

Tarsus bare and deep yellow. Claws black. Primary, secondary and tail feathers sprouting and dark brown in colour. Primaries about two and a half inches long and growing rapidly. Back still covered with down. Gape yellow, Nostrils till lores deep yellow, Bill black and in shape similar to adults' though smaller. Tarsus bare and deep yellow. Minute feather quills appearing like black spots also sprouting on crown and nape. Lores similar to adults' but dirty white in colour. Ear holes black. Eyes and pupil black. Upper wings have a mottled appearance due to down showing through between the smaller secondaries and the tertiary feathers. Forehead downy. Neck sides to shoulder downy. Lower neck sports a few growing feather quills. Underside — Breast light brown. Belly centre light brown with sides downy. Tibia downy with scattered brown spots.

Young would spend its time alternately preening and standing in the nest. As wing feathers were well developed young would make use of any available patch of sunlight on the nest to dry its wings. Sunshine or not, the young would hold its wings away from its body sometimes stretching them taut to dry. During the final stage extremely energetic bouts of wing flapping were observed. Honey-combs would now be held in talons like the adults reminiscent of a parakeet. A feed would be followed by crosswise wiping of bill on nest-rim sticks.

On an average about 7-8 feeding visits per day were made to the nest by the adults. No visits were made during rainy spells and actual time spent by adults at the nest was short, about a minute or less. On some relatively clear days upto 12 to 15 visits per day were recorded but on the 10th August 14 feeds almost alternatively by both adults were observed between 12.50 p.m. to 4.10 p.m. In this case both the Honey-buzzard pair were active in bringing prey. It would be interesting to know whether the male also helps in incubation. A lot of fresh green sprays were usually visible in the nest but never observed being brought indicated that this activity was usually carried out very early in the morning. Both adults continued feeding till the young was independent of the nest.

Towards the end of the secondary stage the young's feathers had grown phenominally fast and the only down visible on the upper parts was between the shoulders and on the forehead, crown and around the lores. Primaries were white-tipped and it spent most of its time preening and stretching its wings forwards and backwards. The young in its final stage was very active and took every advantage of strong gusts of wind to flap its wings, sometimes continuing for over a minute if the gust of wind was exceptionally strong. It would also hop across the nest exercising its wings. A rainy spell was always endured by standing up in the nest with some initial vigorous wing flapping. Post downpour period was always followed by meticulous preening of back and breast feathers (from base to tip), with wings stretched out to dry. Around 10.viii.83 young had become a

more accomplished feeder and could tear up a chameleon competently and swallow it.

In appearance the young was now a uniform dark brown above and uniformly light brown on the underside, except for its cheeks and lores. The tail had also grown. Remaining down on forehead was rapidly disappearing.

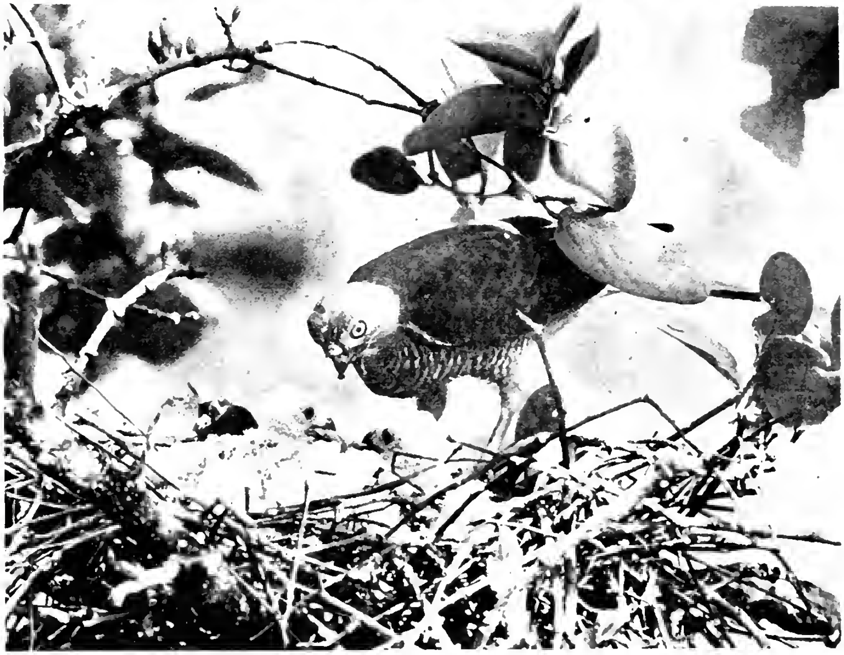
On 10.viii.83 and 14.viii.83 the young was fed so much that its crop was swollen pushing aside the dark brown chest feathers that concealed it when the crop was empty. By 18.viii.83 young was consistently eating chameleons on its own, moving out of the nest perching on topmost branches of the nest tree 6-7 ft. above the nest, dependent on the nest only at night and during feeds.

The curved and twisted ends of chameleon tails posed a swallowing problem to the young after swallowing the body. The tail would be straightened out with the right or the left foot depending on which side of the beak the curved end was protruding. The young was now extremely active during its last two and a half weeks in the nest and flapping of wings now increased in tempo. By 22.viii.83 the nest had been flattened and there being not much difference in height between the nest-cavity and the nest-rim. By this time the young was almost the same size as the adults, a bit plumper and not as streamlined. An unusually energetic display was observed on 22.viii.83, the last day of observation. From the nest the young clambered up a vertical limb supporting the nest to its right frantically flapping its wings at a blurring speed never before observed (plate 6). It then hopped to a branch to the left of the nest later flying directly to a perch to the right of the nest. Extensive preening at this stage was meticulously done after heavy rains making use also of available wind and sunlight if any to dry its feathers. Each individual primary feather was attended to from the rachis base to the tips. Tail and breast feathers were similarly preened. On 9.ix.83 the nest was found to be empty.

Food and Hunting

In mid-July the young of Honey-buzzards are around 15 days to a month old. Young at 15 days are capable of feeding themselves partially only on small fleshy parts of honey combs, swallowing large pieces when fed more adequately by the female (plate 6). At this age whole chameleons cannot be swallowed and have to be fed piecemeal to the young. Honey combs are brought in the feet and sometimes in the bill. Chameleons always in the bill. During feeds the female would feed herself if the fledging was slow in accepting a morsel. When a feed is over the ♀ often lowers her head deep in the nest cavity to retrieve remaining bits of flesh and comb. Once after completing a feed, the ♀ retrieved the dried remains of a chameleon from the nest cup, reminiscent of a parakeet by transferring the discoloured remains from her beak to her right talons by bringing her foot upto bill level and back to her bill. This extraordinary and versatile use of the feet had never before been observed by me with other raptors. Both young and adults have this trait. Holding the hardened remains in her right foot at neck level she broke off pieces of putrified flesh standing on her left foot.

Prey brought by both adults consisted solely of Honey combs (yellowish white from 4-7 inches in diameter) and chameleons. No feeds were observed during rainy spells. The '83 monsoon being unusually heavy very few feeds were in fact observed each day, always during a lull in the rain. On 10.viii.83 however 14 feeds were observed between 12.45 p.m. in the afternoon and 4.10 p.m. in the evening. It was a wet, cloudy rain filled monsoon day and



Above : Honey-buzzard — A rare picture of both adults at the nest. Note the difference in the coloration of the eyes and the plumage. Young has just been given both feeds which can be seen in its beak. A honey comb and the tail of a chameleon near its right eye can be clearly seen.

Below : Shikra (*Accipiter badius*) —Female with fledglings tugging on a Calotes.

(*Photos*: Author)

these were in fact the only dry hours during the whole day. I reached the hide at 12 noon due to morning's heavy rain and left at 4.15 p.m. when it got overcast after which it rained incessantly till 12 p.m. midnight. Out of these 14 feeds just three consisted of honey combs, the rest being chameleons. The first honey comb was eaten by the young on its own at 12.55 p.m., the second eaten partially at 1.10 p.m. the third being untouched. The eleven chameleons, some brought whole and others dismembered were swallowed. How did the adults manage to locate and procure such a large number of chameleons in such a short time ? Both adults fed young almost alternatively.

tarsus half way. Eyes black while the other lighter adult presumably the male had the eyes bordered by a yellowish orange circle (plate 7). Some birds have ruby red eyes. This eye colour difference in adult birds could be due to differences in age and varying also between male and female. Neck long and beak thin and weak. Upper tail black with a broad white band.

Young was very active in the nest alertly watching *S. cheela* call overhead, pecking and playing with sticks and preening during this early downy stage. Alarm calls of birds alerted it into looking around intently for the adults. Honey-buzzards though common near human settlements were found to be extremely shy at

Visits

	2.44 p.m.,	2.59 p.m.,	3.15 p.m.,	3.28 p.m.,	3.35 p.m.,	3.43 p.m.,	4.09 p.m.
Lighter adult		√		√	√		
Darker adult	√		√			√	√

	2.44 p.m.,	2.59 p.m.,	3.15 p.m.,	3.28 p.m.,	3.35 p.m.,	3.43 p.m.,	4.09 p.m.
Lighter adult		√		√		√	
Darker adult	√		√		√		√

Voice & Calls, Description and General Behaviour at Nest

At a destroyed nest where a Honey-buzzard young disappeared, characteristic mournful calls vaguely reminiscent of the wailing of a kitten calling for its mother "peeuw peeecuw" were emitted by the ♀. With two pairs observed it was noticed that one adult assumed to be the ♂ in each pair was considerably lighter than the other, mainly on the breast. Lores with scale like feathers lighter than rest of the head. Upper parts are uniformly light to dark brown. Wings dark brown and underside uniformly brown. Tibia covered with pale brownish white feathers covering the brownish yellow

the nest and ready to desert given the slightest cause. Of course as with all raptors some pairs were shyer than others.

Other Raptors

Around the 12th of May, while the Hawk-eagle's downy young were being reared, the Serpent eagles incubating, Honey-buzzards mating and displaying prior to nesting, Shikras were rearing their young. A Shikra's and Sparrow-hawk's nest were both located in Sadar (*Terminalia tomentosa*) trees.

The Shikra nest contained two young nestlings and an addled egg (Plate 7). The egg remained in the nest for 7 days. During feeding the ♀ made conscious efforts to feed both

young alternatively. The prey brought to the nest were solely *Calotes versicolor*, a favourite prey also of the Hawk-eagles. The hot hours were spent brooding and the ♀ would tuck the young under her belly, sitting lightly over them with wings half open. One of the pair presumably the male was seen driving away a trespassing eagle. On 5.vi.83 the fully-fledged young were seen perched outside the nest, flapping their wings. Brooding amongst these raptors especially during the early stages of nestling development was almost continuous during the hot hours of the day. While Serpent eagles would sit lightly over their young, the Hawk-eagles rarely did so. They would crouch or stand over their young shading them from the sun with their wings and feathers sometimes slightly puffed out.

General remarks and inter intra species reactions

One evening while observing the Hawk-eagle nest No. 2 at around 6 p.m. the female arrived at the nest. 120 metres away amongst the only tall tree remaining in the nearby seasonal river-bed a Hawk-eagle was heard calling, after the female had settled in the nest. On investigating I noticed a brown fish-owl perched before me and a few minutes later spotted the Hawk-eagle to my left. It was a juvenile and its plumage considerably differed from that of the adults. It's head and crest was light brown, underparts pure white (neck to lower belly) with faint vertical brownish streaks. Tarsus pure white, underparts of wings dark; back and rump mottled with white and brown. Call identical to that of the adult *Spizaetus cirrhatus*. The owl flew off and the juvenile flew half-heartedly in pursuit settling nearby. Last year's young?

There was no apparent competition between the various species of raptors observed. In fact I believe that competition would rarely arise unless prey populations declined drastically.

Food/prey competition appears improbable as:

1) though different species nest in close proximity to each other their nesting periods are different, though some overlapping occurs between the Accipiters & Hawk-eagles, Hawk-eagles and Serpent eagles, Serpent-eagles and Honey-buzzards.

2) Each species have their prey preferences. *C. spizaetus* prefer *Calotes*, lizards, ground birds etc., *S. cheela* mainly snakes though here too some prey species are common to both Serpent and Hawk-eagles, e.g. lizards and bush rats which supplement to a lesser extent their major snake diet. Honey-buzzards take mainly honey combs, chameleons and other small prey like rodents. They rear their young when the Serpent eagles have almost finished nesting. Thus, if prey population densities remain at normal levels no conflict should arise as most of the prey species appear to be numerous. A small decline would not cause any severe competition for food while a great calamity, e.g. a raging fire or excessive floods might have a temporary set back on prey populations causing perhaps a change of prey preferences, e.g. Serpent eagles preying mainly on *Calotes* and *Ranas* whose numbers may even temporarily increase due to a decline in snake numbers. Man-made encroachment and random destruction & exploitation of the habitat however ensures that prey population are permanently affected resulting in a sharp decline in raptor numbers.

On no occasion was any aggression seen between pairs of different species. The male *C. spizaetus* was seen quite often near nest No. 4 of *S. cheela* and from the Hawk-eagle hide I could hear and see Serpent eagles every day, close to the Hawk-eagle nest and soaring

above it. The adults Hawk-eagles never gave them more thought than just an upward glance. That pair of *S. cheela* were in fact incubating about a 10 minutes walk away on 10.v.83 when the young Hawk-eaglet was 32 days old, while other nearby *S. cheela* nests had already hatched.

Conclusion

From the above basic observations restricted mainly to nests it is clear that more extensive and detailed work is necessary in areas of predator-prey relationships and prey preferences at different times and in different study areas. More details are required on pairing off and mating behaviour, how pair bonds are established, accurate time periods of incubation, the sex's role during incubation and post fully fledged period. Detailed work is also necessary in ascertaining the average territory of a species by studying and mapping the movements of individual pairs before and after the nesting season. Territorial areas might also fluctuate with different study areas depending on prey/density populations. How long do the young remain with the adults, do the same pairs nest every year, and how do they survive if they do and adjust to a changing environment ? Most of these questions are left largely unanswered. Yet the present observations and data will hopefully be useful for future workers.

Breeding success appeared to be more successful in Crested Serpent eagles and Honey-buzzards as compared to the Hawk eagles. As Hawk-eagles tend to nest on high isolated trees, their large nests stand out conspicuously especially during the incubation and fledgling period when the trees are bare thus making them more vulnerable to human attacks. As these eagles have a tendency to attack village poultry during the nesting season, their nests are often tampered with, the eggs being removed or young killed. Often the nest-tree is chopped down if the nest is inaccessably high. The local 'gowals' or herdsmen sometimes also eat the eggs. Thus a very small proportion of Hawk eagle young survive to maturity. Serpent eagle and Honey buzzard nests are usually lower and more difficult to locate. Serpent eagle nests that do stand out generally mingle with the surrounding foliage due to their low height making them inconspicuous. The Honey-buzzards on the other hand incubate when the monsoon is well under way and all their nests found were almost completely hidden from view.

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of the local labour in the area came in very useful during periods when labour was scarce and had to be mobilized and disciplined when building machans. To Mr. J. C. Daniel my thanks for his willing help and assistance and to staff members of the B.N.H.S. namely Robert Grubh, Isaac Kehimkar and Eric D'Cunha. Alusius Gnanasekar kindly sketched the map and line drawings. Carl D'Souza kindly prepared the sketch at short notice. Mr. Deshpande, Vice Principal of the Ranger's College, Rajpipla, helpfully identified all the tree species. The Forest Dept staff at Rajpipla and Dediapada were helpful, co-operative and courteous.

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REVISED NOMENCLATURE FOR TAXA IN WYNTER-BLYTH'S BOOK ON THE BUTTERFLIES OF INDIAN REGION — II[1]

R. K. VARSHNEY[2]

[*Continued from Vol.* 76(1): 40]

In an earlier paper five families were dealt with, namely: Danaidae, Satyridae, Amathusiidae, Papilionidae and Pieridae (Varshney 1980, *J. Bombay nat. Hist. Soc. 76*(1): 33-40). Three more families: Lycaenidae, Acraeidae and Hesperiidae, are covered in this paper.

Family LYCAENIDAE

The largest family of butterflies, comprising about a third of the total species of butterflies recorded from the Indian region (*vide* Table, in Wynter-Blyth's book, p. 12). Talbot has not dealt with this family in his two volumes of the FAUNA OF BRITISH INDIA-*Butterflies*, 2nd edition. However, after Wynter-Blyth's book, two very important revisions of this family are available, as follows:

(i) Evans, W. H. 1957. A revision of the Arhopala group of Oriental Lycaenidae (Lepidoptera: Rhopalocera). *Bull. Br. Mus.* (*Nat. Hist.*), *Ent.*, *5* (3): 85-141.

(ii) Cantlie, K., 1962. *The Lycaenidae portion* (*except the Arhopala group*) *of Brigadier Evans' The Identification of Indian butterflies* 1932 (*India, Pakistan, Ceylon, Burma*). (Mimeographed). Bombay Natural History Society: vi + 156 pp. (+ 12 pp. Index), 5 pls.

Besides, a number of revisionary papers on different genera and a book of Corbet & Pendlebury (1956, THE BUTTERFLIES OF MALAY PENINSULA, 2nd ed.) are available for detailed studies on this family. Some of the former may be indicated in Table 5A.

For a revised classification of this family Clench (1955, *Ann. Carneg. Mus.*, *33*: 261-275) and Eliot (1973, *Bull. Br. Mus.* (*Nat. Hist.*) *Ent.*, *28*: 373-505) may be followed.

It appears that Wynter-Blyth has listed most of the species, particularly in this family, from the famous work of Evans (1932, IDENTIFICATION OF INDIAN BUTTERFLIES, 2nd ed.). Cantlie (1962, *l.c.*) has revised Evans's work, sometimes remarking "no change in Evans". Cantlie's work is an important guide on this family and I am compelled to cite it repeatedly in my notes below.

Major nomenclatorial changes may be indicated as follows:

Poritia was revised by Corbet (1940, *Trans. R. ent. Soc. Lond.*, *90*: 337-350), where *pleurata* was changed to *phama.* However, he restored the former some years later (Corbet, 1948, *Proc. R. ent. Soc. Lond.*, *17*(7-8)). Eliot (1957, *l.c.*) disregarding Corbet's later action has upheld *phama*, since *pleurata* is a Malayan species and not Burmese. *Miletus* is prior name

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TABLE 5A

Genus	Recent references
Poritia:	Eliot, 1957, *Entomologist, 90*: 70-74.
Miletus:	Eliot, 1961. *Bull. Raffles Mus. Singapore, 26*: 154-177.
Tarucus:	Evans, 1955, *Entomologist, 88* (1107).
Magisba:	Sanders, 1954, *J. Bombay nat. Hist. Soc., 52*(4): 803-830.
Celastrina, Lycaenopsis:	Corbet, 1936, *Proc. R. ent. Soc. Lond., B5*(10): 185-186.
	Corbet, 1937. *Trans. R. ent. Soc. Lond., 86*: 19-33.
	Evans, 1953. *J. Bombay nat. Hist. Soc., 51*(3): 755.
Catochrysops:	Tite, 1959, *Entomologist, 92*(1157): 201-212.
Nacaduba:	Tite, 1963. *Bull. Br. Mus. (Nat. Hist.) Ent., 13*(4): 69-116.
	Eliot, 1955, *Proc. R. ent. Soc. Lond., B24*(9-10): 153-158.
Chrysozephyrus [and allied genera earlier included in *Thecla*]:	Howarth. 1957, *Bull. Br. Mus. (Nat. Hist.) Ent., 5*(6): 233-285.
	Shirozu & Yamamoto, 1956, *Sieboldia, 1*(4): 329-421.
Curetis:	Evans. 1954, *Entomologist, 87*(1098): 190-194; 212-216.
	Shirozu & Yamamoto, 1957, *Sieboldia, 2*: 43-51.
Cheritra, Cheritrella, Ticherra:	Cowan, 1967, *Bull. Br. Mus. (Nat. Hist.) Ent., 20* (3): 77-103.
Narathura [and allied genera earlier included in *Amblypodia*]:	Evans, 1957 (*l.c.*).
Drupadia:	Corbet, 1948, *Proc. R. ent. Soc. Lond. B17*: 98-102.
	Cowan, 1966. *Ann. Mag. nat. Hist.* (13) *9*: 417-418.

than *Gerydus*. *M. longeana* and *chinensis* have been treated by Evans (1932) and some other workers as separate species, but Eliot (1961, *l.c.*) considered them conspecific. *Gerydus* [=*Miletus*] *symethus* has been shown by Wynter-Blyth as occurring in Naga Hills and Burma. Cantlie has expressed doubt on this distribution. *G. biggsi* which has been shown in Wynter-Blyth's book to occur in Burma, with one record from Coorg, is corrected as *nymphis porus* (Eliot 1961, *l.c.*). The nominate *biggsi biggsi* of Distant, which is very rare, is restricted to Victoria Point in Burma.

Corbet (1939, *Trans. R. ent. Soc. Lond., 89*(5): 63-78) has revised *Allotinus*. Following it, as well as the arrangement in British Museum (Nat. Hist.), Cantlie has agreed that *multistrigatus* is merely the wet season form [WSF] of *drumila*, but surprisingly he has treated them as two separate subspecies, namely *A. d. drumila* and *A. d. multistrigatus.* It seems undesirable, since the latter is established by Corbet as WSF of *drumila.* Thus, disagreeing with Cantlie, the subspecies *A. drumila multistrigatus* de Niceville, *sensu* Cantlie, (1962, p. 26) is synonymized with *A. d. drumila* Moore [syn. nov.]. These two seasonal forms shall retain the names *drumila* for DSF and *multistrigatus* for WSF, but then the seasonal form names are not species group names and not covered by the International Code of Zoological Nomenclature.

In genus *Spalgis*, *epius* is corrected as *epeus*. In *Tarucus*, *theophrastus* is changed as *indica*, because the former is confined to Africa and Arabia (*vide*, Evans 1955, *l.c.*). *Pithecops hylax* (Fabricius, 1775), is really a species of *Zizula* (Corbet, 1940, *Entomologist*, *73*(40): 275-277), while the species of *Pithecops* is *corax* Fruhstorfer, 1919 (see Opinion No. 822 of I.C.Z.N., 1967). Cantlie reports after genitalia studies that Evans (1932) has mistakenly described *Everes diporides* for *E. dipora* and vice versa.

The Hedge cupid, *Bothrinia chennelli* has been included by Wynter-Blyth among the species of *Lycaenopsis* without demarcation.
He simply stated 'a closely related genus' in parenthesis. It is an unique departure in Wynter-Blyth's book, since all genera have been separately dealt with and numbered clearly even when only one species is included. Cantlie feels *Bothrinia* resembles *Celastrina* closely, but he has placed it in between *Everes* and *Megisba*. At another place, Cantlie has mentioned that *Bothrinia* and *Cupido* (a Palaearctic genus) differ from each other 'in respect of habitat' and due to the presence of androconia in the latter. While Wynter-Blyth has used *Lycaenopsis* in a very broad way, this treatment has not found favour with later workers. It is now divided into three genera, of which all species included by Wynter-Blyth now come under *Celastrina* (see Cantlie 1962, p. 49). Genus *Moorea* was formed to separate *vardhana* from *binghami* in genus *Notarthrinus*. However, *Moorea* turned out to be preoccupied and was replaced by *Arletta* by Hemming. Corbet (1936, *Proc. R. ent. Soc. Lond.*, *B5*(10)) may be referred to for changes in this complex.

The Common Hedge Blue butterfly, called by Wynter-Blyth as *Lycaenopsis puspa*, has been revised by Cantlie as *Celastrina puspa lavendularis*, but he has restricted its distribution to Sri Lanka only. It looks odd since the Common Hedge Blue is a commonly occurring and very widely distributed butterfly of which Wynter-Blyth gives the range as Peninsular India, Himalayas, Assam, Ceylon and Burma. The Plain Hedge Blue butterfly recorded by Wynter-Blyth as *Lycaenopsis lavendularis* and shown as very widely distributed, too has been restricted by Cantlie to Sri Lanka only as *C. limbata amitra*. There seems to be no error in this case, since two other sub-species of *limbata* occur in the range shown by Wynter-Blyth.

Incidentally, non-inclusion in Wynter-Blyth's book of the change in name of *Lycaenopsis lavendularis* to *Celastrina limbata amitra* made by Evans (1953, l.c.), has substantiated my earlier assumption concerning the period of writing of Wynter-Blyth's book. Although this book was published in 1957, its text must have been prepared perhaps during the war years (*vide*, my paper in this *Journal*, *76*(1): 33).

In genus *Celastrina*, Evans (1930, *J. Bombay nat. Hist. Soc.*, *51*(3)) has synonymized *argiolus sikkima* with *jynteana*, making the latter a subspecies of *argiolus*, on the basis of genitalia. Corbet (1938, *Trans. R. ent. Soc. Lond.*, *87*(5); 1940, *Proc. R. ent. Soc. Lond.*, *B9*) has shown that *quadriplaga* is not conspecific with *dohertyi*. It seems that what was called *quadriplaga dohertyi* by Evans (1932), was retained by Wynter-Blyth as *quadriplaga* only, in accordance with his constant usage of avoiding subspecies names. It is due to this usage that it may appear from the correction list below in present paper that *Celastrina* (= *Lycaenopsis*) *quadriplaga* is synonymous to *C. dohertyi*, which is not so.

Wynter-Blyth has included a large number of species in *Polyommatus*, but on the basis of later studies these species are now placed

in 13 different genera and such treatment is in general use already for Palaearctic butterflies. Under *Polyommatus* s. str. in our area, now only two groups of species remain — one with smooth eyes and other with hairy eyes (see Cantlie, 1962, p. iii for detailed discussion).

Chapman (1910, *Trans. R. ent. Soc. Lond., 1910*: 479-497) divided *Zizera* into *Zizina, Zizeeria and Zizula.* Evans (1932) treated all of them under *Zizeeria* (mark, not *Zizera*) and Wynter-Blyth has followed the same. However, Corbet & Pendlebury (1956) have resurrected these 3 genera and divided them on the basis of geographical distribution also. *Zizeeria gaika* (Trimen, 1862) is synonymous with *Papilio hylax* Fabr. 1775 (*vide* Corbet, 1940, *Entomologist, 73*: 277) and is now placed in *Zizula* as its type species. *Zizeeria otis* has been shown to occur in Ceylon also by Wynter-Blyth, but Cantlie has not reported any of the two subspecies of *otis* from Ceylon. Nominotypical *otis otis* is confined to China.

Catochrysops is in some works (not Wynter-Blyth) cited as *Catachrysops,* which is erroneous (*vide* Hemming, 1929, *Ann. Mag. nat. Hist.* (10) *3*: 217). Wynter-Blyth reported *C. lithargyria* as very rare in Ceylon, but not rare in Burma. Cantlie (1962, l.c.) shows *panormus* as the species name and *lithargyria* is its subspecies restricted to Ceylon only. The Burmese subspecies is *panormus exiguus. Lampides boeticus* also has not been shown to occur in Burma by Cantlie .

Generic name *Anthene* has priority over *Lycaenesthes. A. lycaenina* and *A. lycaenoides* are not conspecific (*vide* Tite, 1963 *l.c.*). In *Jamides, cleodus* is now treated as a separate species than *pura* and is restricted to Philippines. Instead *pura* is raised as species for our region (*vide* Riley & Corbet, 1938, *Trans. R. ent. Soc. Lond., 87*(5): 147-159). The spelling of *J. coerulea* needs correction as *caerulea.* Genus *Orthomiella* has been erroneously cited as *Orthiomella* by Cantlie (1962, pp. 7, 73).

For *Nacaduba,* I have followed in Table 6 the revision by Tite (1963, l.c.). *N. calauria evansii* in Cantlie (1962) should be emended to *evansi.* However, in corrigenda of his book (affixed to p. 157) Cantlie states that Cowan has pointed out *evansi* as a homonym and substituted it by *toxopeusi. N. dana* has been placed in *Petrelaea,* following Corbet & Pendlebury (1956, l.c.).

In a few cases, the measurement of wing-span has been founded to vary. For example in *Lycaena kasyapa,* it has been shown by Wynter-Blyth as 27-32 mm and by Cantlie as 30-36 mm. In *Callophrys rubi,* the fore wing length has been shown by Wynter-Blyth as 28-32 mm and by Cantlie as 20-32 mm. Secondly, while many races of various species in Evans's and Wynter-Blyth's books have been upgraded as subspecies in Cantlie's book, it has not been done in the case of *L. kasyapa* var. *zariaspa.* A rare, major lapse in Cantlie's work is on p. 89 listing *Strymon assamica* in the place of *S. sassanides.* He has tried to correct this on p. 156. For *L. panava* (Wd.) in place of *L. pavana* Hors., see my note in this *Journal, 81*(2): 493-494.

Listeria is preoccupied, hence substituted with *Pamela* by Hemming (1935, *Stylops, 4* (1)). *Heliophorus* is studied in detail by Riley (1929, *J. Bombay nat. Hist. Soc., 33*: 384-402). *Iraota rochana boswelliana* is further recorded from Nongpoh, Khasi Hills by Best (1954, *J. Bombay nat. Hist. Soc., 52*: 365-373). *Curetis thetis saronis* is restricted to Andamans and the subspecies found from Assam to Burma is *C. t. gloriosa. Mahatala* in Wynter-Blyth is an incorrect subsequent citation of *Mahathala* and the former is sup-

pressed here. *Thaduca m. multicaudata* is from S. Burma; the South Indian subspecies is *T. m. kanara. Zesius* has been mis-spelt as *Zezius* in Cantlie's work. *Catapoecilma* in Wynter-Blyth should be *Catapaecilma,* and *Deudoryx* should be corrected as *Deudorix* (*vide* Hemming, 1967, *Bull. Br. Mus.* (*Nat. Hist.*) *Ent. Suppl.,* 9).

All species of *Amblypodia* (*Arhopala*) are now placed in three other genera: *Narathura* (most spp.), *Panchala* and *Flos* (*vide,* Evans, 1957, l.c.). All species of *Thecla* are now placed in five other genera: *Chrysozephyrus* (most spp.), *Esakiozephyrus, Teratozephyrus, Neozephyrus* and *Euaspa* (*vide,* Shirozu & Yamamoto, 1956, l.c.).

While subspecies category has been thoroughly utilized in Indian butterflies, it is rather surprising that subgenus category has been ignored. I take this opportunity to plead for the introduction of subgenera in this field. There are certain genera, which are quite large considering the number of species they contain. They are presently divided in various ways, like 'Groups' etc. The case under reference is that of *Narathura.* Evans (1957, l.c.) has recognized 12 'Groups' of which some have been further divided into 'Subgroups'. In this case, altogether 73 species are reported under *Narathura* from the Indian region only. Since the arranging of such a large number of species is obvious, all these 'Groups' and 'Subgroups', in my opinion, are fit to be treated as subgenera, which is a recognized category of Zoological Nomenclature, while 'Group' etc. are not. Evans's study of *Arhopala* Group ["Group of genera"] is excellent. I am convinced that his 'Groups' of species and Subgroups' of species, will eventually be recognized as definite taxonomic units, being well defined and segregated by morphological characters, I am therefore inclined to treat them as subgenera. Accordingly, all the Groups and Subgroups of *Narathura* are treated as of subgeneric level here [subgen. nov.] and cited as such in the correction list below (see Table 6). *'Epimuta'* Group and Sub-group, which contain the type species *hypomuta,* are synonymized with nominate *Narathura* subgenus [Syn. nov.].

Evans (1957) and Cantlie (1962) however, have a minor flaw, in my opinion, which is found existed in Evans's famous work of 1932 also. In all these treatises, the author's name of species and subspecies where the genus has subsequently changed has not been enclosed in parentheses. Such use of parentheses is necessary under Article No. 51 (d) of the International Code of Zoological Nomenclature and is a very common and useful practice. In the above works of Evans and Cantlie, while parentheses in author's name has been ignored, there is no other indication also to show whether a species was originally described in the given genus in which it is reported or some other genus. This flaw has naturally made difficult the preparation of the correction list for this paper. I have made only a limited effort to correct. Needless to add that except for this point, the works of Evans and Cantlie are the best on Indian Lycaenidae (See Table 6).

Family ACRAEIDAE

This Ethiopian family is represented by only two species in the Indian region. Wynter-Blyth has placed these two species under two different genera, *Pareba* and *Telchinia.* However, Talbot (1947, FAUNA OF BRITISH INDIA-*Butterflies,* 2nd ed., 2) has recorded both genera as synonyms of *Acraea.*

The species name needs to be changed too in one case. Hemming (1967, *Bull. Br. Mus*

5

TABLE 6

LYCAENIDAE

Page No.		For	Correct
		Subfamily PORITIINAE	
1.	252	*Poritia pleurata* Hewitson	*Poritia phama geta* Fawcett
2.	253	*Simiskina phalena* Hewitson	*Simiskina phalena harterti* (Doherty)
		Subfamily MILETINAE [syn. GERYDINAE]	
3.	253	Genus *Gerydus* [Bdv.]	Genus *Miletus* Huebner
4.	,,	*Gerydus boisduvali* (Moore)	*Miletus chinensis assamensis* Doherty
5.	254	*Gerydus longeana* de Niceville	*Miletus chinensis longeana* (de Niceville)
6.	,,	*Gerydus biggsi* Distant	*Miletus nymphis porus* Eliot
7.	,,	*Gerydus symethus* (Cramer)	*Miletus symethus petronius* Dist. & Pryer
8.	255	*Allotinus horsfieldi* (Moore)	*Allotinus horsfieldi continentalis* Fruh.
9.	,,	*Allotinus drumila* (Moore)	*Allotinus drumila drumila* (Moore) [DSF]
10.	,,	*Allotinus multistrigatus* de Niceville	*Allotinus drumila drumila* (Moore) [WSF]
11.	,,	*Allotinus subviolaceus* Felder	*Allotinus subviolaceus manychus* Fruh.
12.	256	*Allotinus fabius*	*Allotinus panormis* Elwes
		Subfamily LYCAENINAE	
13.	256	*Spalgis epius* (Westwood)	*Spalgis epeus epeus* (Westwood)
14.	258	*Taraka hamada* (Druce)	*Taraka hamada mendesia* Fruh.
15.	261	*Castalius elna* (Hewitson)	*Castalius elna noliteia* Fruh.
16.	,,	*Castalius roxus* (Godart)	*Castalius roxus roxana* de Niceville
17.	262	*Tarucus dharta* Bethune-Baker	*Tarucus waterstradti dharta* Bethune-Baker
18.	263	*Tarucus alteratus* Moore	*Tarucus nara* (Kollar) [DSF]
19.	264	*Tarucus theophrastus* [Fabr.]	*Tarucus indica* Evans
20.	,,	*Tarucus extricatus* [Butler]	*Tarucus nara* (Kollar) [DSF]
21.	,,	*Tarucus nigra*	*Tarucus balkanica nigra* Bethune-Baker
22.	,,	*Tarucus mediterraneae* [Bethune-Baker]	*Tarucus rosacea* Distant
23.	267	*Azanus jesous* (Guerin)	*Syntarucus jesous gamra* (Lederer)
24.	268	*Pithecops hylax* Fabricius	*Pithecops corax* Fruh.
25.	270	*Everes argiades* (Race *indica*) [Evans]	*Everes hugelii hugelii* Gistel
26.	,,	*Everes argiades* (Race *hellotia*) [Men.]	*Everes argiades thibetanus* Lorkovic
27.	,,	*Everes diporides*	*Everes argiades diporides* Chapman
28.	,,	*Everes dipora*	*Everes hugelii dipora* (Moore)
29.	,,	*Everes parrhasius*	*Everes lacturnus syntala* Cantlie
30.	274	*Lycaenopsis puspa*	*Celastrina puspa lavendularis* (Moore)
31.	,,	*Lycaenopsis lilacea*	*Celastrina puspa lilacea* (Hampson)
32.	275	*Lycaenopsis vardhana*	*Arletta vardhana* (Moore)
33.	,,	*Lycaenopsis albocerulea*	*Celastrina albocaerulea* (Moore)
34.	,,	*Lycaenopsis lanka*	*Celastrina lanka* (Moore)
35.	,,	*Lycaenopsis akasa*	*Celastrina akasa mavisa* Fruh.
36.	277	*Lycaenopsis albidisca*	*Celastrina carna albidisca* (Moore)
37.	,,	*Lycaenopsis marginata* [de Niceville]	*Celastrina carna marata* Corbet

Page No.		For	Correct
38.	„	*Lycaenopsis transpecta*	*Celastrina transpecta* (Moore)
39.	278	*Lycaenopsis cardia*	*Celastrina dilecta* (Moore) [new emend.]
40.	„	*Lycaenopsis musina*	*Celastrina musina musinoides* Swinhoe
41.	„	*Lycaenopsis lavendularis*	*Celastrina limbata* (Moore)
42.	279	*Lycaenopsis huegelii*	*Celastrina huegelii* (Moore)
43.	„	*Lycaenopsis ladonides*	*Celastrina ladonides gigas* Hemming
44.	„	*Lycaenopsis argiolus*, race *kollari*	*Celastrina argiolus kollari* (Westwood)
45.	280	*Lycaenopsis argiolus*, race *sikkima* [Moore]	*Celastrina argiolus jynteana* (de Niceville)
46.	„	*Lycaenopsis jynteana*	*Celastrina argiolus jynteana* (de Niceville)
47.	„	*Lycaenopsis quadriplaga*	*Celastrina dohertyi dohertyi* Tytler
48.	281	*Lycaenopsis melaena*	*Celastrina melaena melaenoides* Tytler
49.	„	*Lycaenopsis minima*	*Celastrina melaena melaenoides* form *minima* Evans
50.	„	*Lycaenopsis binghami*	*Celastrina binghami* (Chapman)
51.	„	*Polyommatus atroguttata*	*Phengaris atroguttata* (Oberthur)
52.	„	*Polyommatus vicrama*	*Philotes vicrama* (Moore)
53.	282	*Polyommatus astrarche*	*Aricia agestis nazira* (Moore)
54.	„	*Polyommatus galathea*	*Albulina galathea* (Blanchard)
55.	„	*Polyommatus cyllarus*	*Glaucopsyche alexis aeruginosa* Staudinger
56.	„	*Polyommatus christophi*	*Lycaeides christophi* (Staudinger)
57.	284	*Zizeeria trochilus* (and *Z. putli*)	*Freyeria trochilus putli* (Kollar)
58.	285	*Zizeeria lysimon*	*Zizeeria knysna karsandra* (Moore)
59.	„	*Zizeeria gaika*	*Zizula gaika* (Trimen)
60.	287	*Euchrysops contracta* (Butler)	*Euchrysops parrhasius* (Fabricius)
61.	288	*Euchrysops pandava* race *minuta*	*Euchrysops parrhasius minuta* Evans
62.	289	*Catochrysops lithargyria* Moore	*Catochrysops panormus* Felder
63.	290-292	Genus *Lycaenesthes* [Moore]	Genus *Anthene* Doubleday
64.	292	*Jamides cleodus* [Felder]	*Jamides pura pura* (Moore)
65.	„	*Jamides celeno* [Cramer]	*Jamides celeno aelianus* (Fabricius)
66.	293	*Jamides kankena*	*Jamides elpis* (Godart)
67.	„	*Jamides coerulea*	*Jamides caerulea* (Druce)
68.	296	*Nacaduba vajuva*	*Nacaduba subperusia* Snellen
69.	297	*Nacaduba helicon*	*Ionolyce helicon* (Felder)
70.	„	*Nacaduba calauria*	*Nacaduba calauria toxopeusi* Corbet
71.	„	*Nacaduba ceylonica*	*Nacaduba sinhala* Ormiston
72.	298	*Nacaduba aluta*	*Nacaduba aluta coelestis* de Niceville
73.	„	*Nacaduba dubiosa*	*Nacaduba dubiosa indica* Evans
74.	„	*Nacaduba dana*	*Petrelaea dana* (de Niceville)
75.	301	*Lycaena pavana* Horsfield	*Lycaena panava* (Westwood)
76.	302	*Lycaena thetis* Klug	*Lycaena solskyi lampon* (Lederer)
77.	„	*Thestor callimachus*	*Tomares callimachus* Eversman
78.	303	*Heliophorus epicles*	*Heliophorus epicles indicus* (Fruh.)
		Subfamily THECLINAE	
79.	307	Genus *Listeria* [de Niceville]	Genus *Pamela* Hemming
80.	308	Genus *Thecla*	Genus *Thecla* Fabr.*

* *Thecla* is not represented in Indian region. See notes.

Page No.		For	Correct
81.	,,	*Thecla icana* Moore	*Esakiozephyrus icana* (Moore)
82.	309	*Thecla bieti* Oberthur	*Esakiozephyrus mandara* (Doherty)
83.	,,	*Thecla ataxus* (Doubleday)	*Chrysozephyrus ataxus* (Db. & Hew.)
84.	310	*Thecla pavo* de Niceville	*Euaspa pavo* (de Niceville)
85.	,,	*Thecla duma* Hewitson	*Chrysozephyrus duma* (Hewitson)
86.	,,	*Thecla zoa* de Niceville	*Chrysozephyrus zoa* (de Niceville)
87.	,,	*Thecla kabrua* Tytler	*Chrysozephyrus kabrua* (Tytler)
88.	311	*Thecla birupa* Moore	*Chrysozephyrus birupa* (Moore)
89.	,,	*Thecla syla* Kollar	*Chrysozephyrus syla* (Kollar)
90.	,,	*Thecla khasia* (de Niceville)	*Chrysozephyrus khasia* (de Niceville)
91.	,,	*Thecla syla* Kollar, Eastern race	*Chrysozephyrus assamicus* (Tytler)
92.	312	*Thecla ziha* de Niceville	*Euaspa ziha* (Hewitson)
93.	,,	*Thecla letha*	*Chrysozephyrus letha* (Watson)
94.	,,	*Thecla suroia*	*Neozephyrus suroia* (Tytler)
95.	,,	*Thecla vittata*	*Chrysozephyrus vittatus* Tytler
96.	,,	*Thecla doni*	*Teratozephyrus tsangkie* (Oberthur)
97.	,,	*Thecla jakamensis*	*Chrysozephyrus jakamensis* (Tytler)
98.	,,	*Thecla kirbariensis*	*Chrysozephyrus kirbariensis* (Tytler)
99.	,,	*Thecla paona*	*Chrysozephyrus paona* (Tytler)
100.	313	*Curetis thetis* form *saronis*	*Curetis thetis gloriosa* Moore
101.	317	Genus *Horsfieldia* [Riley]	Genus *Amblypodia* Horsfield
102.	318	Genus *Mahatala* [Wynter-Blyth]	Genus *Mahathala* Moore
103.	,,	*Mahatala atkinsoni* Hewitson	*Apporasa atkinsoni* (Hewitson)
104.	,,	*Thaduka multicaudata* Moore	*Thaduka multicaudata kanara* Evans
105.	,,	Genus *Amblypodia*	Genus *Narathura* Moore
106.	320	*Amblypodia camdeo*	*Narathura* (*Camdeo*) *camdeo* (Moore)
107.	,,	*Amblypodia silhetensis*	*Narathura* (*Cleander*) *silhetensis* (Hewitson)
108.	,,	*Amblypodia yendava*	*Narathura* (*Aedias*) *aedias yendava* (Grose-Smith)
109.	,,	*Amblypodia singla*	*Narathura* (*Eumolphus*) *singla* (de Niceville)
110.	321	*Amblypodia bazalus*	*Narathura* (*Eumolphus*) *bazalus teesta* (de Niceville)
111.	,,	*Amblypodia eumolphus*	*Narathura* (*Eumolphus*) *eumolphus eumolphus* (Cramer)
112.	,,	*Amblypodia bazaloides*	*Narathura* (*Acetes*) *bazaloides bazaloides* (Hewitson)
113.	,,	*Amblypodia ormiston*	*Narathura* (*Agaba*) *ormistoni* (Riley)
114.	,,	*Amblypodia amantes*	*Narathura* (*Eumolphus*) *amantes* (Hewitson)
115.	,,	*Amblypodia ganesa*	*Panchala ganesa* (Moore)
116.	322	*Amblypodia paraganesa*	*Panchala paraganesa* (de Niceville)
117.	,,	*Amblypodia centaurus*	*Narathura* (*Centaurus*) *centaurus* (Fabr.)
118.	,,	*Amblypodia oenea*	*Narathura* (*Atrax*) *oenea* (Hewitson)
119.	,,	*Amblypodia khamti*	*Narathura* (*Atrax*) *oenea khamti* (Doherty)
120.	,,	*Amblypodia canaraica* [Moore]	*Narathura* (*Atrax*) *alea* (Hewitson)
121.	,,	*Amblypodia alemon* [de Niceville]	*Narathura* (*Atrax*) *atrax* (Hewitson)
122.	323	*Amblypodia rama*	*Narathura* (*Rama*) *rama* (Kollar)
123.	,,	*Amblypodia dodonea*	*Narathura* (*Rama*) *dodonaea* (Moore)
124.	,,	*Amblypodia perimuta*	*Narathura* (*Perimuta*) *perimuta* (Moore)
125.	,,	*Amblypodia paramuta*	*Narathura (Rama) paramuta paramuta* (de Niceville)

Page No.		For	Correct
126.	„	*Amblypodia abseus*	*Narathura (Abseus) abseus indicus* (Riley)
127.	324	*Amblypodia diardi*	*Flos diardi diardi* (Hewitson)
128.	„	*Amblypodia fulgida*	*Flos fulgida fulgida* (Hewitson)
129.	„	*Amblypodia adriana*	*Flos adriana* (de Niceville)
130.	„	*Amblypodia asoka*	*Flos asoka* (de Niceville)
131.	„	*Amblypodia chinensis*	*Flos chinensis* (Felder)
132.	„	*Amblypodia areste*	*Flos areste* (Hewitson)
133.	325	*Amblypodia fulla*	*Narathura (Fulla) fulla ignara* (Riley & Godfrey)
134.	„	*Amblypodia anarte*	*Narathura (Anthelus) anarte anarte* (Hew.)
135.	„	*Amblypodia opalina*	*Narathura (Camdeo) opalina* (Moore)
136.	„	*Amblypodia suffusa*	*Narathura (Aedias) allata suffusa* (Tytler)
137.	„	*Amblypodia ace*	*Narathura (Atrax) ace arata* (Tytler)
138.	„	*Amblypodia agrata*	*Narathura (Atrax) agrata binghami* (Corbet)
139.	„	*Amblypodia agaba*	*Narathura (Agaba) agaba* (Hewitson)
140.	„	*Amblypodia alax*	*Narathura (atrax) alax* (Evans)
141.	„	*Amblypodia paralea*	*Narathura (Agaba) paralea* (Evans)
142.	„	*Amblypodia comica*	*Narathura (Rama) comica* (de Niceville)
143.	„	*Amblypodia asopia*	*Narathura (Agelastus) asopia* (Hewitson)
144.	„	*Amblypodia arvina*	*Narathura (Agaba) arvina ardea* (Evans)
145.	„	*Amblypodia ammon*	*Panchala ammonides* (Doherty)
146.	„	*Amblypodia birmana*	*Panchala birmana birmana* Moore
147.	„	*Amblypodia aberrans*	*Panchala aberrans* (de Niceville)
148.	„	*Amblypodia ellisi*	*Panchala aberrans* (de Niceville)
149.	326	*Amblypodia apidanus*	*Flos apidanus ahamus* (Doherty)
150.	328	*Surendra quercetorum* Moore	*Surendra vivarna* (Horsfield)
151.	330	*Yasoda tripunctata* (Hewitson)	*Yasoda pita tripunctata* (Hewitson)
152.	333	*Spindasis syama*	*Spindasis syama peguanus* (Moore)
153.	„	*Spindasis lohita*	*Spindasis lohita himalayanus* (Moore)
154.	337	*Pratapa vidura* (Horsfield)	*Pratapa penicilligera* (de Niceville)
155.	341	*Tajuria jangala* (Horsfield)	*Remelana jangala ravata* (Moore)
156.	345	*Tajuria albiplaga*	*Tajuria jalajala albiplaga* de Niceville
157.	„	*Tajuria sebonga*	*Tajuria jalajala pallescens* Druce
158.	„	*Tajuria thyia*	*Tajuria jalajala thyia* de Niceville
159.	„	*Tajuria luculentus*	*Tajuria luculentus nela* Swinhoe
160.	347	Genus *Neocheritra* [Distant]	Genus *Jacoona* Distant
161.	349	Genus *Biduanda* [Distant]	Genus *Drupadia* Moore
162.	„	*Biduanda melisa* (Hewitson)	*Drupadia scaeva cyara* (Hewitson)
163.	351	*Horaga moulmeina* Moore	*Horaga syrinx moulmeina* Moore
164.	„	Genus *Catapoecilma*	Genus *Catapaecilma* Butler
165.	„	*Catapoecilma elegans* (Druce)	*Catapaecilma major* (Fruh.)
166.	354	*Hypolycaena erylus* (Godart)	*Hypolycaena erylus himavantus* Fruh.
167.	355	*Zeltus etolus* (Fabricius)	*Zeltus amasa* (Hewitson)
168.	356	Genus *Deudoryx*	Genus *Deudorix* Hewitson
169.	„	*Deudoryx hypargyria* (Elwes)	*Deudorix hypergyria* Elwes
170.	361	*Rapala sphinx* [Fabr.]	*Rapala elcia nicevillei* Swinhoe
171.	„	*Rapala schistacea*	*Rapala manea schistacea* (Moore)
172.	„	*Rapala buxaria*	*Rapala rectivitta* (Moore)
173.	362	*Rapala melampus*	*Rapala iarbus sorya* (Kollar)
174.	„	*Rapala jarbas*	*Rapala iarbus iarbus* (Fabricius)
175.	363	*Rapala pheritima*	*Rapala pheretima petosiris* (Hewitson)

(*Nat. Hist.*), *Ent. Suppl.*, 9: 344) has shown that *Pareba vesta* (Fabricius 1787) is a homonym of *Papilio vesta* Cramer, 1777, and thus it should be rejected. It has been substituted by *issoria* Huebner, 1819 [not 8819 as given in Hemming].

Regarding the other species, *A. violae*, it may be stated that in the *Fauna* volume by Talbot (1947, *l.c.*) its distribution has been shown as Ceylon and Peninsular India only, which should be corrected. This butterfly is common in North and Eastern India also, as recently pointed out by Varshney (1973, *Curr. Sci.* 42(3): 107). Wynter-Blyth has also shown wide distribution under 'habits' of this species (see Table 7).

For the revision of names of taxa in this family, I have followed Evans (1949, A CATALOGUE OF THE HESPERIIDAE FROM EUROPE, ASIA AND AUSTRALIA IN THE BRITISH MUSEUM (NATURAL HISTORY): 502 pp.), to a large extent, alongwith his subsequent paper [Evans, 1956, *Ann. Mag. nat. Hist.*, (12)9 (106): 749-752]. Wynter-Blyth himself recommended the former (p. 458, foot-note).

The important changes in the generic names are as follows: *Syrichtus* has been changed to *Spialia*, because the former was erected by Boisduval for some European skippers. *Ismene* Swainson is invalid, being a junior homonym of *Ismene* Savigny, which is a vertebrate genus. The species of *Ismene* have now been placed under *Bibasis*. Generic name *Astychus* in Wynter-Blyth's book is an incorrect spelling for *Astycus* Huebner. However, the latter name also is an invalid name, being a junior objective synonym of *Erynnis* Schrank, vide Hemming (1967, Generic names of Butterflies and their type-species, *Bull. Br. Mus.* (*Nat. Hist.*) *Ent. Suppl.*, 9: p. 63). The Indian species of *Astycus* have now been placed under *Telicota* Moore, following Evans (1949, *l.c.*). Genus *Padraona* Moore is a junior subjective synonym of *Potanthus* Scudder. The old genus *Baoris* (s.l.) has been split up and its Indian species have been distributed among many genera.

TABLE 7

ACRAEIDAE

Page No.		For	Correct
1.	234	Genus *Pareba* [Doubleday]	Genus *Acraea* Fabricius
2.	..	*Pareba vesta* (Fabricius)	*Acraea issoria* (Huebner)
3.	235	Genus *Telchinia* [Huebner]	Genus *Acraea* Fabricius
4.	,,	*Telchinia violae* Fabricius	*Acraea violae* (Fabricius)

Family HESPERIIDAE

In Wynter-Blyth's book, names have partially been corrected at the printing stage, for the family Hesperiidae also, besides Papilionidae and Pieridae. The style of correction is: "*Baoris oceia* (now *B. farri*)" (p. 484), or "Genus *Syrichtus* (now *Spialia*)" (p. 466). These corrections are not only insufficient, but in some cases erroneous also, *e.g.*, Wynter-Blyth has placed some species of *Baoris* in the corrected genus *Polytrema* (p. 485), which should be *Polytremis*, as no genus with the name *Polytrema* has ever been proposed in the butterflies.

However, in the following few cases I have not agreed with the findings of Evans (1949) as adopted in Wynter-Blyth's book: (i) Generic name *Celaenorrhinus* has been cited as *Celanorrhinus,* which is an incorrect subsequent spelling. (ii) Generic name *Hasora* has been replaced by *Chromus,* in Wynter-Blyth's book (p. 467), apparently following Evans's work. However, no genus called *"Chromus"* has been ever proposed for the butterflies. Hemming (1967, l.c.) has also not catalogued any such genus. In my opinion *Hasora* is an available valid name. It appears that in Wynter-Blyth's book, the correction of species name *alexis* to *chromus* has been mistakenly put for the genus and printed as *"Hasora* (now *Chromus*)". (iii) Generic name *Sancus* has been corrected to *Psolos* in Wynter-Blyth's book. Evans (1949, p. 278) has brought forward the name *Psolos* Staudinger in place of *Sancus* de Niceville. However, *Psolos* Staudinger is a manuscript name and it was originally published as a synonym. Therefore, it is invalid under Article 11 (d) of the International Code of Zoological Nomenclature. Thus, *Sancus* is the oldest valid name applicable to this genus.

For the species names, the changes may be summarised as follows: *Hasora alexis* to *H. chromus; Astychus pythias* to *Telicota ohara jix; Halpe egena* to *H. homolea; H. moorei* to *H. porus; Baoris oceia* to *B. farri; B. philippina* to *Caltoris brunnea caere*; *B. contigua* to *Polytremis lubricans; B. zelleri* to *Borbo cinnara;* and *Sancus pulligo* to *S. fuligo* (See Table 8).

A few other points may be clarified: (i) Wynter-Blyth has divided this family into 9 subfamilies "following the arrangement of Bell" (p. 459). However, Evans (1949) has revised the classification and recognized only 3 subfamilies, all of which occur in the Indian region. The third subfamily, Hesperiinae, however, has been split up into a number of 'Genus Groups'. (ii) Regarding Sl. Nos. 20 and 21 in Table 8 below. Wynter-Blyth himself has stated in a note (p. 478) that both *Astychus pythias* and *A. augias* are now classified as mere 'forms' of *Telicota ancilla.* (iii) The author of *Pelopidas assamensis* is shown as de Niceville by Evans (1949, l.c.), but Swinhoe (1912, *Lep. Indica, 10*: 311) shows that both Wood-Mason and de Niceville are authors of this species, which appears correct. (iv) For *Parnara naso bada* in place of *guttatus* (Sl. No. 41 in Table 8), my note with Shri Nandi, published recently in this *Journal* (*77*(1): 157-158) may be seen.

Like Lycaenidae, in this family also I faced the difficulty of proper use of parentheses on author's name of a species, since Evans (1932, 1949, 1956) has altogether ignored this practice. However, I consider the use of parentheses, as recommended under the rules, as an useful tool to differentiate the changed combinations from the original. Therefore, I adhere to it. For this purpose, besides other papers, I have followed Swinhoe's monumental work (1911-13, LEP. INDICA, Vol. *9, 10*) and placed the parentheses appropriately in Table 8.

TABLE 8

HESPERIIDAE

Page No.		For	Correct
1.	459	Subfamily 1. CELAENORRHINAE	Subfamily PYRGINAE
2.	460	*Celaenorrhinus ruficornis* (Mabille)	*Celaenorrhinus ruficornis fusca* (Hampson)
3.	461	*Tagiades obscurus* Mabille	*Tagiades japetus* (Stoll)
4.	,,	*Tagiades distans* Moore	*Tagiades japetus* (Stoll)
5.	462	*Tagiades atticus* (Fabr.)	*Tagiades japetus atticus* (Fabr.)
6.	466	Subfamily 2. HESPERIINAE	Subfamily PYRGINAE
7.	,,	Genus *Syrichtus* [Boisd.] (now *Spialia*)	Genus *Spialia* Swinhoe
8.	467	Subfamily 3. ISMENINAE	Subfamily COELIADINAE
9.	,,	Genus *Hasora* (now *Chromus*)	Genus *Hasora* Moore
10.	,,	*Hasora alexis* (Fabr.)	*Hasora chromus chromus* (Cramer)
11.	468	*Hasora vitta* Butler	*Hasora vitta indica* Evans
12.	,,	Genus *Ismene* [Swainson] (now *Bibasis*)	Genus *Bibasis* Moore
13.	470	*Choaspes benjaminii* (Guerin)	*Choaspes benjamini* (Guerin-Meneville)
14.	471	Subfamily 4. PLASTINGIINAE	Subfamily HESPERIINAE
15.	473	Subfamily 5. ERIONOTINAE	Subfamily HESPERIINAE
16.	474	*Erionota thrax* (Huebner)	*Erionota thrax* (Linn.)
17.	,,	Subfamily 6. PAMPHILINAE	Subfamily HESPERIINAE
18.	478	Subfamily 7. ERYNNINAE	Subfamily HESPERIINAE
19.	,,	Genus *Astychus* [=*Astycus* Huebner] (now *Telicota*)	Genus *Telicota* Moore
20.	,,	*Astychus augias* (Linn.)	(i) *Telicota augias* (Linn.) (ii) *Telicota ancilla bambusae* (Moore)
21.	,,	*Astychus pythias* (Mabille)	*Telicota ohara jix* Evans
22.	479	*Oriens gola* (Moore)	*Oriens gola pseudolus* (Mabille)
23.	,,	*Oriens concinna* (Elwes)	*Oriens concinna* (Elwes & Edwards)
24.	,,	Genus *Padraona* [Moore] (now *Potanthus*)	Genus *Potanthus* Scudder
25.	480	*Halpe egena* (Felder) now *H. homolea* (Hewitson)	*Halpe homolea hindu* Evans
26.	481	*Halpe moorei* Watson, now *H. porus* Mabille	*Halpe porus* (Mabille)
27.	,,	*Halpe honorei* de Niceville, now *Thoressa honorei* de Niceville	*Thoressa honorei* (de Niceville)
28.	483	*Baracus hampsoni* Elwes	*Baracus vittatus hampsoni* Elwes & Edwards
29.	484	Subfamily 8. BAORINAE	Subfamily HESPERIINAE
30.	,,	*Baoris oceia* [Moore] (now *B. farri*)	*Baoris farri farri* (Moore)
31.	,,	*Baoris canaraica* (now *Caltoris canaraica*)	*Caltoris canaraica* (Moore)
32.	,,	*Baoris kumara* (now *Caltoris kumara*)	*Caltoris kumara* (Moore)
33.	485	*Baoris philippina* [Herrich-Schaeffer]	*Caltoris brunnea caere* (de Niceville)
34.	,,	*Baoris contigua* [Mabille] (now *Polytrema lubricans*)	*Polytremis lubricans* (Herrich-Schaeffer)
35.	,,	*Baoris eltola* (now *Polytrema eltola*)	*Polytremis eltola* (Hewitson)

Page No.		For	Correct
36.	„	*Baoris discreta* (now *Polytrema discreta*)	*Polytremis discreta* (Elwes & Edwards)
37.	„	*Baoris assamensis* (now *Pelopidas assamensis*)	*Pelopidas assamensis* (Wood-Mason & de Niceville)
38.	„	*Baoris conjuncta* (now *Pelopidas conjuncta*)	*Pelopidas conjuncta* (Herrich-Schaffer)
39.	„	*Baoris sinensis* (now *Pelopidas sinensis*)	*Pelopidas sinensis* (Mabille)
40.	486	*Baoris mathias* (now *Pelopidas mathias*)	*Pelopidas mathias* (Fabr.)
41.	„	*Baoris guttatus* [Bremer & Grey] (now *Parnara guttatus*)	*Parnara naso bada* (Moore)
42.	„	*Baoris zelleri* [Lederer] (now *Borbo cinnara*)	*Borbo cinnara* (Wallace)
43.	„	*Baoris bevani* (now *Borbo bevani*)	*Borbo bevani* (Moore)
44.	489	Subfamily 9. NOTOCRYPTINAE	Subfamily HESPERIINAE
45.	„	*Notocrypta feisthamelii* (Boisduval)	*Notocrypta feisthamelii alysos* (Moore)
46.	491	Genus *Sancus* (now *Psolos*)	Genus *Sancus* de Niceville
47.	„	*Sancus pulligo* (Mabille)	*Sancus fuligo subfasciatus* (Moore)

DISTRIBUTION AND VARIABILITY OF THE SRI LANKAN PIPE SNAKE (*CYLINDROPHIS MACULATUS*)[1]

ERIC S. BACHMAN[2]

(*With three text-figures*)

INTRODUCTION

The genus *Cylindrophis* is endemic to south-eastern Asia and *Cylindrophis maculatus,* its westernmost species, is restricted to the island of Sri Lanka (Smith 1943). This note provides a detailed summary of its range on the island and discusses variation of character states. It is based on material collected as part of the activities of C. Gans, as well as on selected museum specimens, and is part of a series of notes on the herpetofauna of Sri Lanka (Gans & Fetcho 1982, Nussbaum & Gans 1980).

METHODS

Forty-two specimens of *Cylindrophis maculatus* were examined; of these thirty-eight have locality data and form the basis of this report. The specimens are derived from the Museum of Comparative Zoology (MCZ), the American Museum of Natural History (AMNH), and the Gans collection, now at the American Museum of Natural History (AMNH), Carnegie (CM) and U.S. National Museum (USNM) (AL, P, CG, F). Most specimens were sexed and numbers of midventrals, caudals, and of rows of scales at midbody and cloaca were recorded (Table 1). Also recorded was the snout-vent length, the diameter of the head, midbody and cloaca, and the tail length. Finally noted were arrangements of the cloacal scales and colour patterns.

METHODS OF COUNTING

The number of *ventrals* was determined by counting the first midventral posterior to the chin shields up to and including the last scale before the cloaca.

The number of *subcaudals* included the first scale posterior to the cloaca up to the distal spine. All tails were sketched.

The number of *scale rows at midbody* were counted from, but not including the midventral row.

The number of *scale rows at the cloaca* included the last midventral scale.

The *total length* was determined by pressing the specimen against a meter stick, or by adpressing string to the snake and measuring the string. The alternative method was used as many specimens had hardened substantially in preservative.

The *caudal length* was measured under a stereomicroscope and *snout-vent* length was recorded as the total length minus the tail length.

The *diameter* of each specimen was measured at neck, midbody and cloaca.

Count of *dorsal spots* started with the two white spots just posterior to the head on either

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TABLE 1

Cylindrophis maculatus DATA

Number Museum	Location	Ventrals	Sub-Caudals	Scale Rows	Cloaca Rows	Total Length	Snout-vent	Tail length	Diameters N	MB	C	Dorsal Spots	Total Spots	Sex
FMNH 121489	2B	210	5	19	16	330	324.5	5.5	6	8	6	47/46	93	F
FMNH 121490	2B	203	4	19	14	370	365	5	6	8.5	6	40/44	84	F
FMNH 165049	7A	225	5	21	16	428	419	9	6	11	7	47/53	100	–
FMNH 165050	7A	219	5	21	16	186	182	4	5	5	4	47/45	92	F
AL 545	8D	222	5	21	16	323	318.5	4.5	5.5	11	6.5	46/50	96	F
AL 586A	8D	197	5	19	14	268	263	5	4.5	7.5	4	47/45	92	–
AL 586B	8D	224	5	21	16	194	190	4	5	4	3	55/55	110	–
AI 591	9A	225	5	21	16	308	303.5	4.5	6	8	6	50/54	104	F
AL 592	9A	226	5	21	16	427	421	6	7	9	7	50/48	98	F
CG 5548	9C	215	5	21	16	344	338	6	6	8.5	5.5	44/46	90	F
FMNH 25928	9C	202	5	21	16	300	293	7	6	8	4.5	39/41	80	–
AL 564	10A	213	5	21	16	397	390	7	7	13	8	48/46	94	F
CG p74/4	10A	217	5	21	15	452	446	6	7	9.5	6.5	47/48	95	F
FMNH 95132	10B	210	5	21	16	365	357	8	7	9	5.5	48/50	98	F
AL 281	10D	203	5	21	14	334	327	7	6	7.5	4.5	45/43	88	M
AL 543	10D	198	5	21	16	168	164.5	3.5	4	7	4.5	40/43	83	M
F 520A	11C	198	4	19	14	127	124	3	3.5	4	2.5	42/42	84	–
AL 670c	11C	203	6	21	16	375	368	7	7	9.5	6.5	44/48	92	M
CG 5546	12A	204	5	19	14	198	191	7	7	10	6	49/47	96	F
CG 5547	12A	197	5	19	14	276	269.5	6.5	6	8	5.5	42/44	86	M
AL 287	12B	203	5	21	14	357	351	6	6	8	5	39/39	78	M
FMNH 120917	12D	205	4	19	16	314	308	6	6	8	5.5	49/53	102	F
FMNH 142395	13A	195	5	19	16	228	222.5	5.5	7	8.5	5	41/41	82	M
AL 329	13A	199	5	19	14	311	305	6	6	9	5	39/40	79	F
FMNH 130982	13A	195	5	19	14	325	317	8	8	8.5	5	38/39	77	M
AL 508	13B	198	6	21	14	160	157	3	5	6	6	41/43	84	–
CG 92503A	13B	209	5	21	16	285	279	6	6.5	12	7	44/46	90	F
CG 5545	13B	196	5	19	14	344	337	7	7	8	5.5	42/42	84	M
CGp74/17	13B	201	5	21	14	350	343.5	6.5	6	7.5	4	41/44	85	M
CG 1000	13B	201	6	19	16	283	276.5	6.5	8	9	6	44/46	90	–

F 398	13B	208	5	21	15	202	198	4	4.5	5	4	47/48	95	–
MCZ 57194	14A	202	5	19	16	276	270.5	5.5	6	7	4.5	48/40	88	F
MCZ 57195	14A	208	5	21	16	367	359.5	7.5	5.5	7	5	49/51	100	F
CG 092581A	14A	218	6	21	16	345	336.5	8.5	6.5	8	4.5	50/51	101	–
CG 092512A	14B	209	5	19	16	361	355	6	7	11	7	52/52	104	F
AL 480	15A	195	5	21	14	275	270	5	7	8.5	5	36/37	73	M
AL 330	16A	200	5	21	16	304	298	6	7	8.5	6.5	43/41	84	F
AL 611	–	223	5	21	16	495	486	9	10	14	8	46/45	91	–
CG 092582	–	218	5	19	16	375	366	9	6	8.5	6	49/54	103	–
MCZ 34886	–	203	5	21	16	308	301.5	6.5	9	9.2	6.5	45/44	89	–

Key to Table 1 is as follows : Specimens are listed according to the order used in locality records, abbreviations for museum names precede specimen number and correspond to names listed in the introduction on page 1, location code corresponds to the map (refer to Nussbaum and Gans 1980). diameters are those of neck, midbody and cloaca, and (M) or (F) in the last column indicates male and female, respectively.

side of the back. The general shape and colour of spots was recorded, but small specks were ignored. The fraction indicates the count for the left side over that for the right.

All specimens were *sexed,* noting the presence of testes and vasa deferentia or ovaries and oviduct through an incision along the ventral surface anterior to the cloaca.

The map reference for each specimen pertains to the map of Sri Lanka seen in figure 1. As in Nussbaum & Gans (1980: Fig. 1), the map of Sri Lanka (1 inch to 1 mile, Survey Department, Colombo) was used with the sixteen north to south divisions given numbers and the west to east sheets given letters. The combination is listed in parentheses after each locality. Spelling of locality names follows those in the Gazetteer of the U.S. Board on Geographical names. The elevation of the localities was determined from field notes or from the maps.

General Observations

Only two meristic characters varied significantly. These are the numbers of ventral scales and the dorsal spots.

Dorsal spots on the two sides of specimens differ : however, Figure 18 shows that two-thirds of the specimens have more spots on the right than on the left side. Hence, comparisons used the total number of dorsal spots.

Vertical distribution was not considered for this paper as only four specimens were definitely collected above 1000 feet.
(The record for Namunukula may be suspect. see Gans & Fetcho, 1982 : 276.)

All specimens (N = 38) showed a direct relation between the number of dorsal spots and the number of ventral scales (Figure 2A).

Variation

The individual variation of two characters

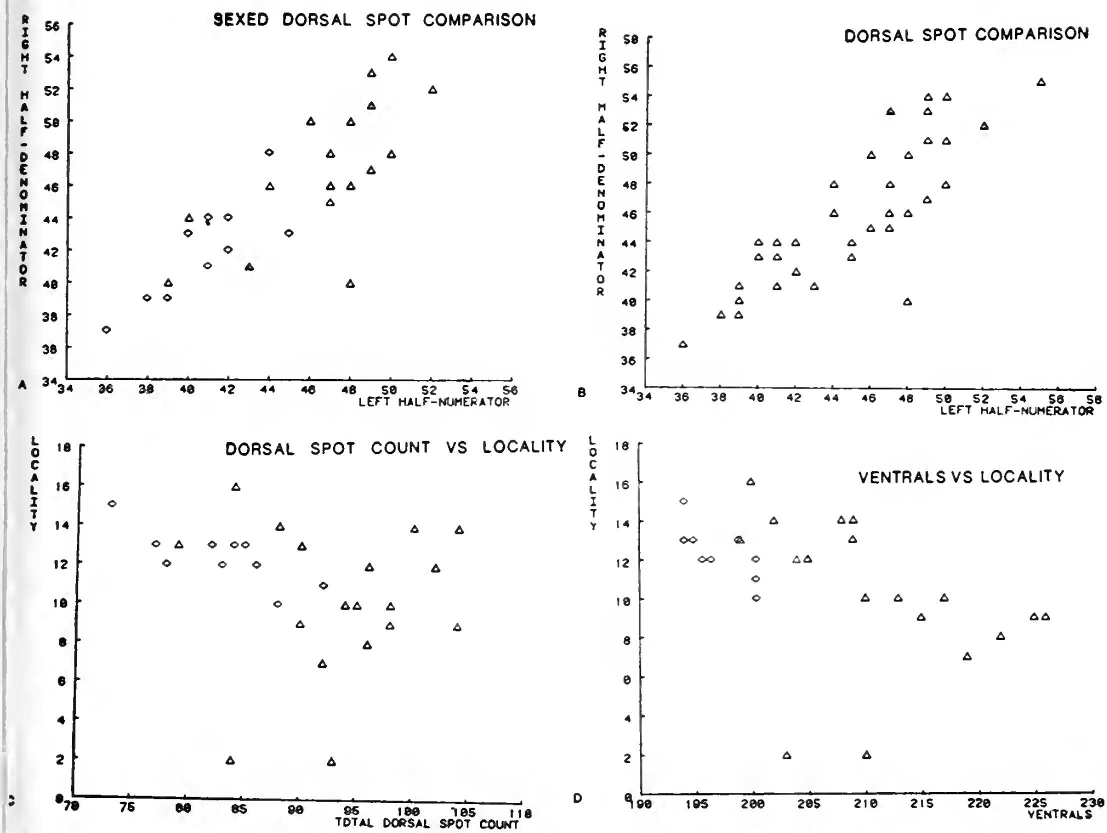

Fig. 1. *Cylindrophis maculatus.* Comparisons of characters. Diamonds and triangles represent males and females, respectively, unless symbols are uniform or unless otherwise indicated. A. Plot of male and female dorsal spots, left half (abscissa) versus right half (ordinate). B. Plot of dorsal spots for entire population. Axes labelled as in A. C. Plots of total count of dorsal spots (abscissa) versus locality (ordinate) for males and females. Refer to Table 1 for locality data. D. Plot of ventral scales (abscissa) versus locality (ordinate) for males and females.

seems to be associated, respecitively with geography and sex. No trends are apparent in the variation of most measured aspects of *Cylindrophis.*

The ventral count of females differed considerably from north to south. As seen in Figure 2B, the ventral counts of specimens from south of the Kandy area are markedly lower (mean = 204, N = 8) than are those of the northern ones (mean = 216, N = 10). The specimens supposedly from Jaffna do not fit this pattern.

Figure 1D reveals that ventral count generally increases from south to north. The Jaffna specimens again disagree.

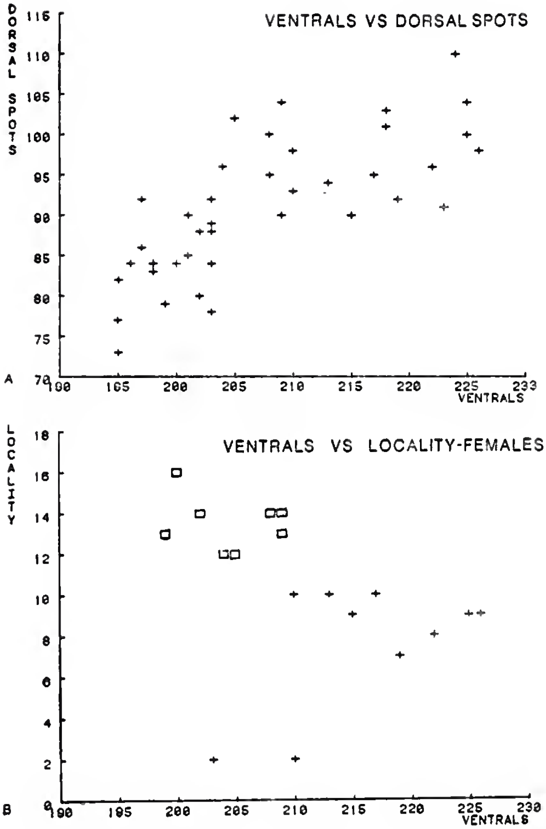

Fig. 2. *Cylindrophis maculatus.* Comparison of characters.

A. Graph of ventral counts (abscissa) versus total number of dorsal spots (ordinate) for the entire population. B. Ventral counts versus locality (refer to Table 1) for southern females (squares) and northern females (plus signs).

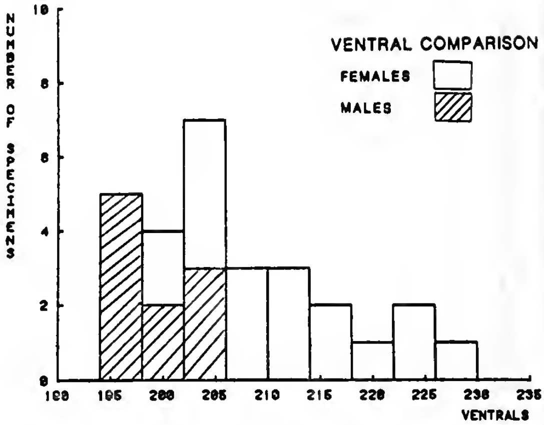

Fig. 3. *Cylindrophis maculatus.* Histogram of ventrals for sexed specimens. Males are shown as striped bars and females as open bars.

Variations associated with sex include characters of ventral scales and dorsal spots. The ventral count of males (N = 10) were markedly lower than those of females (N=18). The histogram in Figure 3 makes this point obvious.

The number of dorsal spots also shows sexual dimorphism (Figure 1A). The males (N = 10, mean = 41/42) have fewer dorsal spots than do females (N = 18, mean = 47/47). The total dorsal count also reveals lower values for males (Figure 1C).

Locality Records

Sri Lanka. Jaffna Lagoon (?) (2B), sea level : *FMNH* 121489-121490. Puttalam (7A), sea level : *FMNH* 165049-165050. Polonnaruwa (8D), elev. 200 ft: (AL 545); CM 93667-93668 (CG 586a-586b). Nawadamkulama, 3 miles from Mundal (9A), sea level : CM 93655, 93662 (AL 591-592); USNM 238005 (CG 092582). Naula (Matale district) (9C), elev. 900 ft : USNM 235802 (CG 5548). Inirigama (Deraniyagala) (9C?) : FMNH 25928. Erunwila, 3 miles from Madampe (10A) : CM 93658 (AL 564). Galamuna (10A) : AMNH 126603 (CG P74/4). Polgahawela, Kandy district (10B) : FMNH 95132. Illukkumbura (10D), elev. 1800 ft : CM 93659 (AL 281). Pallewatta (10D) : CM 93666 (AL 543). Kandy (11C): CM 93653-93654 (F 520A-520B). Gampola (11C), elev.

470 m : CM 93657 (AL 670c). Boralesgamuwa (Colombo district) (12A), elev. 30 ft: AMNH 126607 (CG 5547). Nugegoda (12A), elev. 30 ft: USNM 235801 (CG 5546). Biyagama, Kelaniya (12B), elev. 50 ft: CM 93661 (AL 287). Namunukula, Uva (12D), elev. 4000 ft : FMNH 120917. Gonapola (13A) : FMNH 142395. Horana (13A), elev. 50 ft : CM 93663 (AL 329); FMNH 130982. Ratnapura (13B), elev. 100 ft : AMNH 126604 (CG P74/17), 126605 (CG 1000), 126606 (CG 5545); CM 93656 (AL 508); USNM 235803 (CG 092503A). Balangoda (13B), elev. 1500 ft : CM 93652 (F 398). Pusnelbombla, Bentota (14A) : MCZ 57194-57195. Kudawa (14A) : USNM 23804 (092581A). Yapitikanda, Deniyaya (14B), elev. 1200 ft : CM 93651 (CG 092512A). Talgaswella (15A), elev. 150 ft : CM 93660 (AL 480). Galle (16A), sea level : CM 93669 (AL 330). No locality : CM 93664-93665 (AL 611); (CG 092582); MCZ 34886.

Acknowledgements

I thank Dr Carl Gans for suggesting and guiding the project and for making the materials collected by him available for study. I appreciate the loan of specimens from several museum collections. See Gans & Fetcho (1982) for acknowledgement of the grants and field assistance involved in the assembly of the materials. Mr P. B. Karunaratne donated some of the specimens. Prepared with assistance from NSF DEB 8121229 (to Gans).

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ADDITIONS IN THE LAST TWO DECADES TO THE ANGIOSPERMS OF WEST BENGAL[1]

B. P. Uniyal[2] and B. C. Banerjee[3]

The paper includes 192 plants which have been added to the Flora of West Bengal during the years 1959-1981.

After Hooker's *Flora of British India*, David Prain's comprehensive consolidated work, which included the area of undivided Bengal and some parts of Bihar and Orissa States, was published in 1903 as Bengal plants. Since then many workers have undertaken collection tours to different regions of West Bengal and published floristic accounts in different scientific journals from time to time. With the re-organisation of the Botanical Survey of India in 1956, more and more collection tours were undertaken by the workers of the Botanical Survey of India in different districts of West Bengal and their new findings were published in different journals including the Bulletin of the Botanical Survey of India. Since those records are scattered, an attempt has been made by us to bring together such information published during the last two decades (1959-1981) with the idea that it will be helpful to the students of the Flora of West Bengal.

Though efforts have been made to accumulate all such information, there might be some ommissions due to non-availability of certain scientific journals.

Names marked with an asterisk (*) denote the 'new species' and with double asterisks (**) denote 'new records for India' from West Bengal and with three asterisks (***) as 'new records for West Bengal'. The names in the list are given as they were originally published without any changes.

[1] Accepted August 1983.

[2] Botanical Survey of India, Dehra Dun, U.P.

[3] Botanical Survey of India, Howrah, W. Bengal.

*** **Abelmoschus manihot** (L.) Medik ssp. **tetraphyllus** var. **tetraphyllus** Borss. Blumea 14: 98. 1966; R. K. Basak in Bull. Bot. Surv. India 10 (3 & 4): 254. 1968.

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*** **I. spicata** Forsk. in Fl. Aegypt. Arab. 138. 1775; Vuppuluri Sharma in Ind. Forester 95. 311. 1961.

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POPULATION ECOLOGY AND COMMUNAL ROOSTING BEHAVIOUR OF PARIAH KITE *MILVUS MIGRANS GOVINDA* IN PUNE (MAHARASHTRA)[1]

Anil Mahabal and D. B. Bastawade[2]

(*With six text-figures*)

Introduction

The Pariah Kite *Milvus migrans govinda* Sykes is a common resident bird found near human habitation in both urban and rural areas. It is widely distributed and found throughout the Indian Union, Pakistan, Bangla Desh, Nepal, Burma, Sri Lanka and Andaman Islands (Ali and Ripley 1968). There is practically no information on its population ecology and roosting behaviour. The present work deals with the above aspects of the life of Pariah Kite studied during 1975-77 in Pune City (Maharashtra State).

Materials and Methods

We have been censusing the major bird species forming communal roosts in Pune city and studying their social behaviour. As a part of this study, communal roosts of Indian Myna, Brahminy Myna, Rosy Pastor, Cattle Egret, Pond Heron, House Sparrow, Roseringed Parakeet, House and Jungle Crow and Pariah Kite have been located. We have observed altogether four permanent and four temporary roosts of the Pariah Kite in the Pune city area (Fig. 1). These eight roosts were censused once a month in the evening for 28 consecutive months from June 1975 to September 1977. Later, these roosts were also censused in two representative months, August 1978 and February 1979. Further, the pre-roosting behaviour of Pariah Kite was observed at their roost at Peshave Park during the years 1979-1983.

Records were maintained on the number of kites arriving at their communal roost in the evening at 5-minute interval. As the kites arrive slowly at the roost, they can be accurately counted. The time of arrival of the first kite and of all the successive arriving birds upto the last one, as well as the total time span of arrival of the birds were noted at each roost. Some observations on their peculiar behaviour, particularly the pre-roosting communal displays, were also made.

Population ecology

The total population of Pariah kites fluctuated monthly and seasonally.

Monthly fluctuations The monthly variations in the total number of kites has been plotted in Fig. 2, which indicates that during the first year of observation (1975-76) the number of kites increased from June 1975 onwards till August 1975 at which time the population reached its peak. From August 1975 onwards, the population declined slowly till January 1976 reaching the lowest level of the year. From January 1976 onwards, a slow rise in

[1] Accepted January 1984.

[2] Zoological Survey of India, Western Regional Station, PUNE - 411 005.

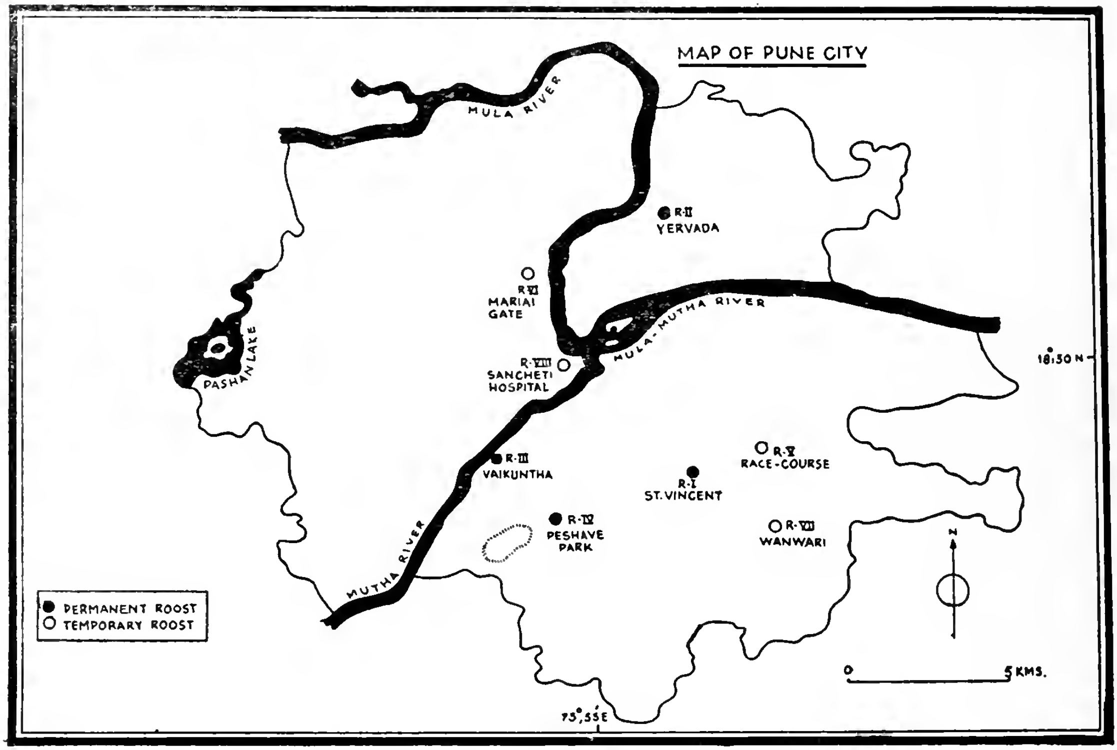

Fig. 1. Map of Pune city showing the location of eight roosts of Pariah kites.

number of kites was again noticed till July 1976.

This pattern of monthly fluctuations in population continued cyclically till September 1977. The censuses carried out in August 1978 and February 1979 also indicated that the population of kites in these months was similar to that in identical months of the two previous years. In general, it was noticed that highest peak in August and the lowest level of population in January seem to be characteristic features of the population of Pariah kites.

Seasonal fluctuations In the biology of Pariah kites, the following three seasons were noticed the pre-breeding season (June to September), the breeding season (October to February) and the post-breeding season (March to May). The pre-breeding season had the highest population as compared to the remaining two seasons during the years of observations (Table 1). The table also indicates that the average populaition is more or less constant for the years 1975-76 and 1976-77.

Factors causing fluctuations in population: The monthly and seasonal fluctuations in the population of Pariah kites described above may be influenced by one or more of the following factors—the immigration of kites into the city area, the emmigration of kites from the city area, addition of newly born young ones to the population.

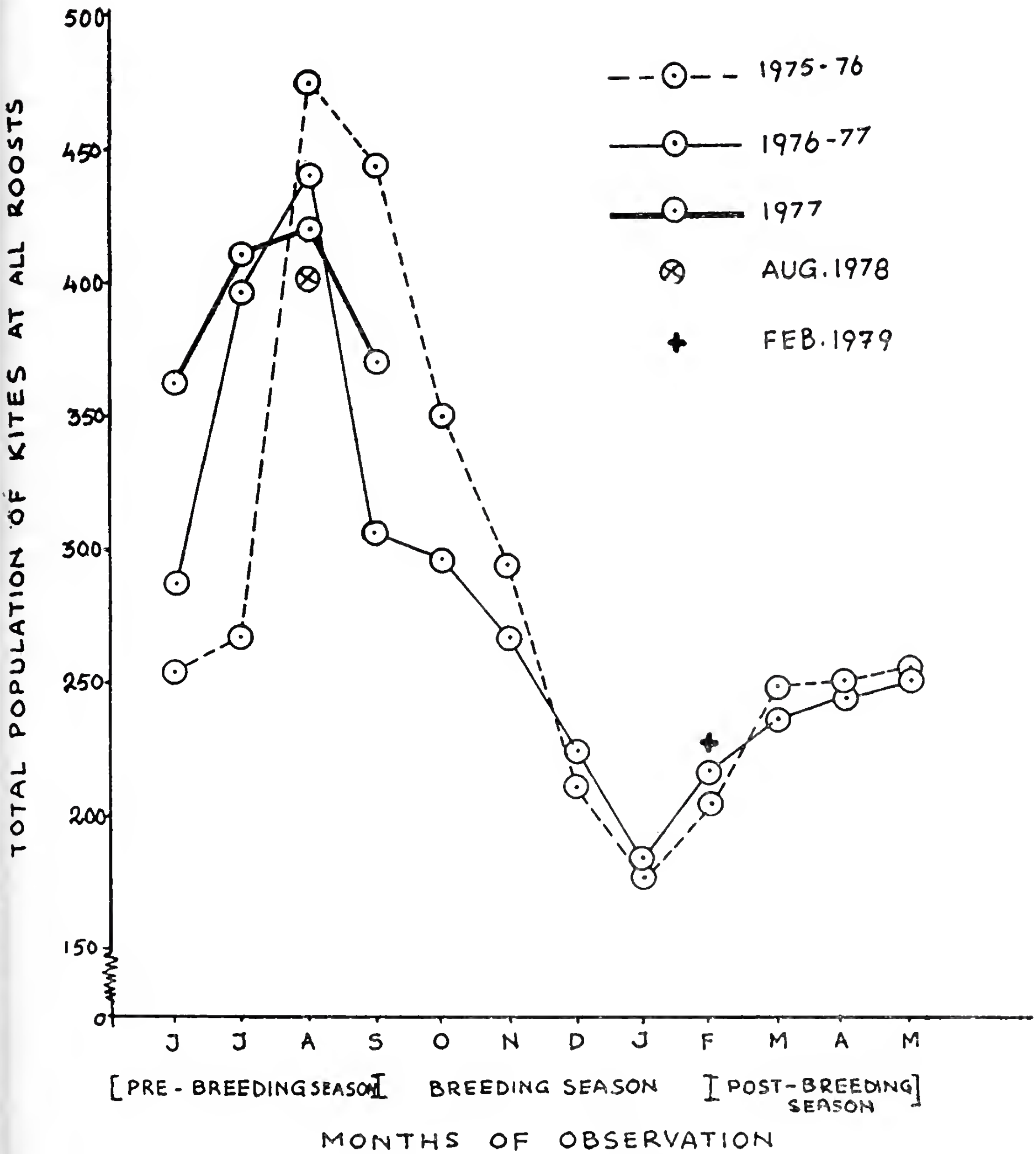

Fig. 2. Monthly fluctuations in total population of Pariah kites in Pune city.

TABLE 1

SEASONAL CHANGES IN THE AVERAGE POPULATION OF KITES DURING THE PERIOD OF STUDY

Season	Year 1975-76	1976-77
Pre-breeding	360.5	357.8
Breeding	246.8	238.4
Post-breeding	251.3	245.0
Average Population per year	285.7	279.8

In all the years of observation, an increase in the number of kites was noticed during the months July to September, coinciding with the monsoon season. This increase seems to be due to the immigration of Pariah kites into the city. This inference is supported by views of various authors. Aitken (1947) has stated that the Common Pariah kites go to Poona from Bombay for the monsoon months. Smythies (1953) has reported that Pariah kite, a common breeding bird in Burma, disappears at the break of rains. He suspects that possibly they migrate to India. Henry (1955) has suspected that Pariah kites migrate from Ceylon to South India with the onset of south-west monsoon and return to the Island by about August. Ali and Ripley (1968) have indicated that Pariah kites migrate from localities of heavy rainfall to drier areas before commencement of monsoon.

Pune gets an average rainfall of about 750 mm per annum. Compared to this, towns like Lonavala (6026 mm per annum), Karjat (3278 mm per annum), Panvel (2741 mm per annum) which are situated to the west of Pune city, receive heavy rainfall. Heavy rainfall may

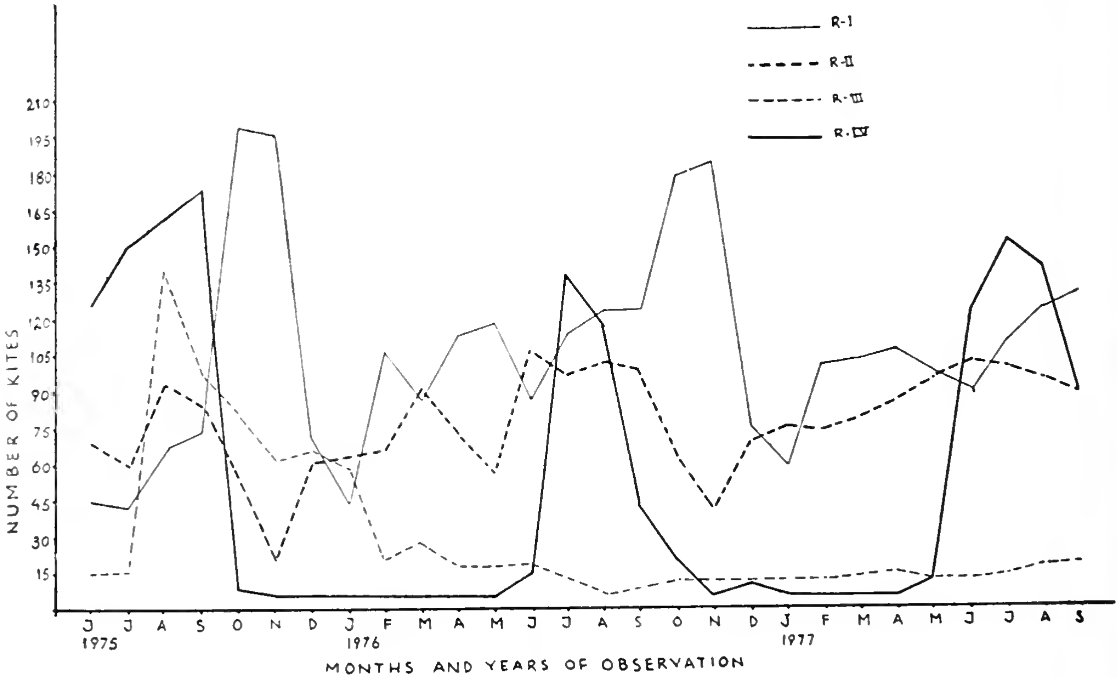

Fig. 3. Monthly changes in the population of kites at four permanent communal roosts.

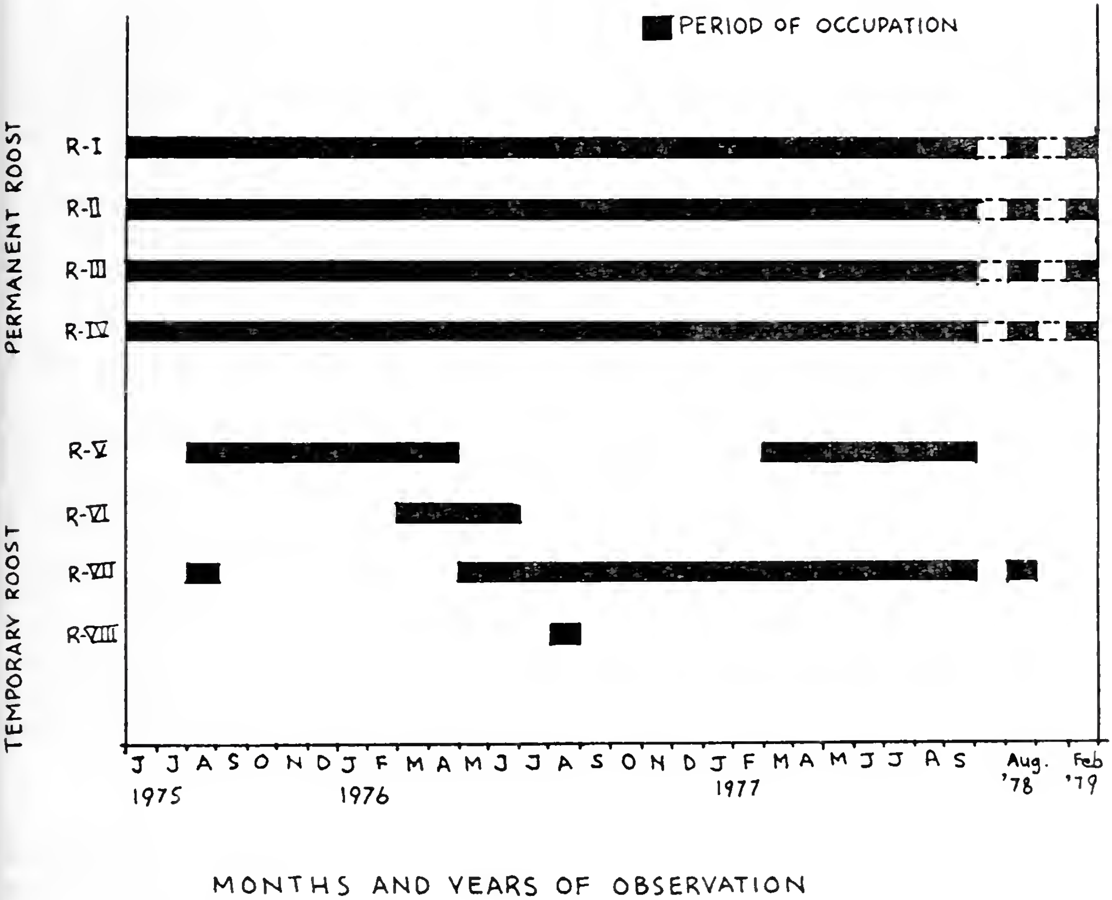

Fig. 4. Periods of occupation of permanent and temporary roosts of Pariah kites during the study period.

cause scarcity of food provoking kites to migrate to lower rainfall areas like Pune where they can get sufficient food.

The slow decrease in population of kites from September onwards may be due to emigration of kites to their original towns for breeding. This could also be related to staying of one of the partners of a breeding pair at the nest for various nesting activities. The slow rise in number of kites from January onwards may be because of addition of newly born young ones which come to the roost along-with their parents.

Fluctuations in dispersal of population among different roosts: Variations in the monthly population of Pariah kites at the four permanent roosts have been shown in Fig. 3. It is seen that at roosts R-I and R-II, fluctuations in number of kites are inversely related to each other. Thus some of the kites seem

to change their roost regularly and periodically. The availability of good food sources may be a factor causing this change of roosts. Further, it can be observed from the Figure that during successive years of study the kites have congregated in large numbers at roost R-IV only during the pre-breeding season and once at roost R-III in 1975. The Figure also indicates that the count of kites at roost R-IV in all the years is negligible except in the pre-breeding season. At roost R-III, the population was markedly reduced after January 1976 and remained at that level throughout the period of observation. It can be noticed from the Figure that kites gathered in large numbers at roost R-I during the early part of breeding season in each year of observation. Among the four permanent roosts, roost R-I has substantial population and hence it can be considered as a major roost of kites in the Pune city. Thus, it was noticed that the population at a communal roost of kites is not constant but it changes from season to season.

Abandoning of roosts and roosting trees:

The roosts were classified into two categories according to the period of their occupation-permanent roosts and temporary roosts. The permanent roosts were occupied by the Pariah kites almost throughout the period of study, while the temporary ones were abandoned frequently or totally during the study period (Fig. 4). The figure indicates the following :

i) During the study period four communal roosts were found to be permanent and the remaining four were temporary.

ii) Of the four temporary roosts, two (R-VI and R-VIII) were observed just for four and one month respectively over the period of study.

iii) The remaining two temporary roosts (R-V and R-VII) were abandoned for a certain period and again reoccupied.

The kites used only a single tree for roosting at each temporary roost. At a permanent roost however, they used 2 to 4 different trees, some of which were abandoned occasionally and again occupied during the period of study. The number of kites at a permanent roost R-IV was occasionally reduced to a very small number, but total abandonment of that roost was not noticed (Fig. 3).

Seasonal changes in the composition of flock sizes:

The flock sizes of Pariah kites arriving at the roost in the evening were recorded throughout the year at all the roosts under observation. The composition of various flock sizes of kites in the pre-breeding, breeding, and post-breeding seasons is shown in Fig. 5. It is clear from the Figure that flocks of more than 3 birds were noticed only in the pre-breeding season. On the whole it is noticed that there is a majority of solitary and paired birds in all the seasons.

Communal roosting behaviour

Roosting sites: Pariah kites were found to occupy four permanent and four temporary roosts during the period of the study in Pune (Fig. 1). It was observed that generally the kites preferred trees like Banyan (*Ficus* sp.) and Tamarind (*Tamarindus* sp.) for communal roosting at night. At a few roosting sites Pariah kites invariably form mixed communal roost in company with Indian Myna *Acridotheres tristis*, Brahminy Myna *Sturnus pagodarum*, House Crow *Corvus splendens* and Jungle Crow *Corvus macrorhynchos*. Beside these species, Rosy Pastor *Sturnus roseus*, Roseringed Parakeet *Psittacula krameri*, Cattle Egret *Bubulcus ibis*, Pond Heron *Ardeola grayii* and House Sparrow *Passer*

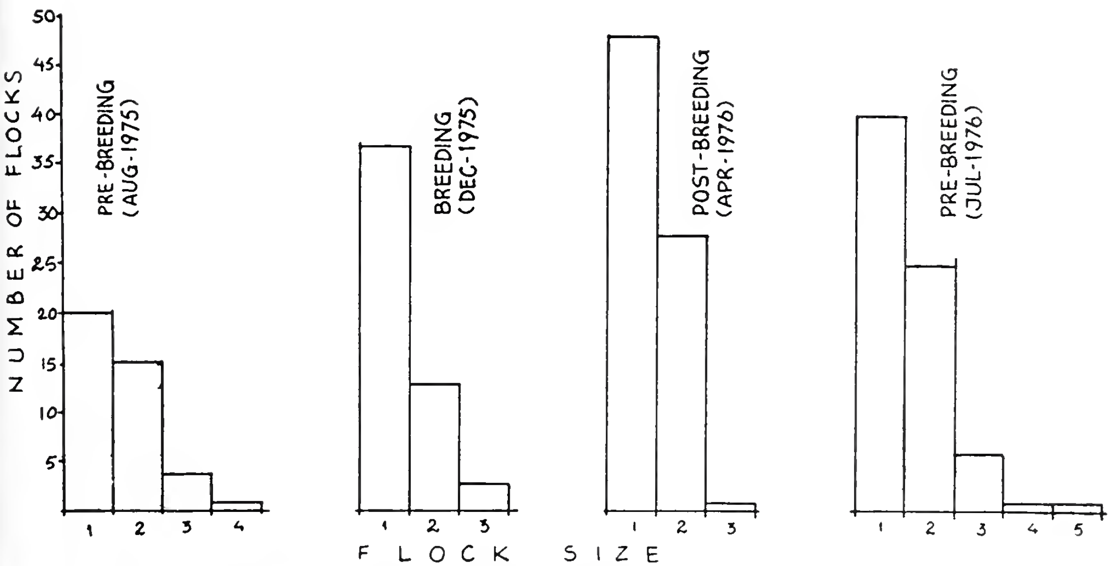

Fig. 5. Flock size composition of kites flying into the communal roost R-I during different seasons.

domesticus were also seen roosting close to the kites as mixed roosting companions. Besides these mixed communal roosts, pure roosts of kites were also noticed particularly at temporary roosts (R-VI and R-VIII) and at some roosting trees at the permanent roost R-I in all the seasons. Such pure roosts have also been reported by Gadgil and Ali (1975).

Daytime activities: Daily activities of Pariah kites start a little before sunrise. All the kites depart from the communal roost 5 to 12 minutes after sunrise, one by one or in pairs. They disperse in different directions for feeding. After leaving the roost, (without making any circular flights overhead) they fly straight in a particular direction very rapidly as if they were in a hurry.

During daytime, the kites were observed feeding either solitarily or gregariously near fish and mutton markets, slaughter houses, garbage dumps, etc. Much of their daytime is spent in manoeuvring in the sky in search of food. Crows often compete with kites and chase them while in search of food.

Pre-roosting behaviour: After spending the daytime in the feeding area in various activities, kites start their movements towards the communal roost in the evening about 30 minutes before sunset. They arrive from different directions, gather above the roost, and manoeuvre in the sky for some time before settling down.

The time assembly of kites at roost R-I at 5-minute interval in different seasons has been plotted in Fig. 6 (a-d). This Figure indicates the following:

i) Kites roost after the time of sunset in all the seasons.

ii) The time of arrival of the first kite at the roost is more or less similar in the breeding and post-breeding seasons, whereas they arrive little later in the pre-breeding season.

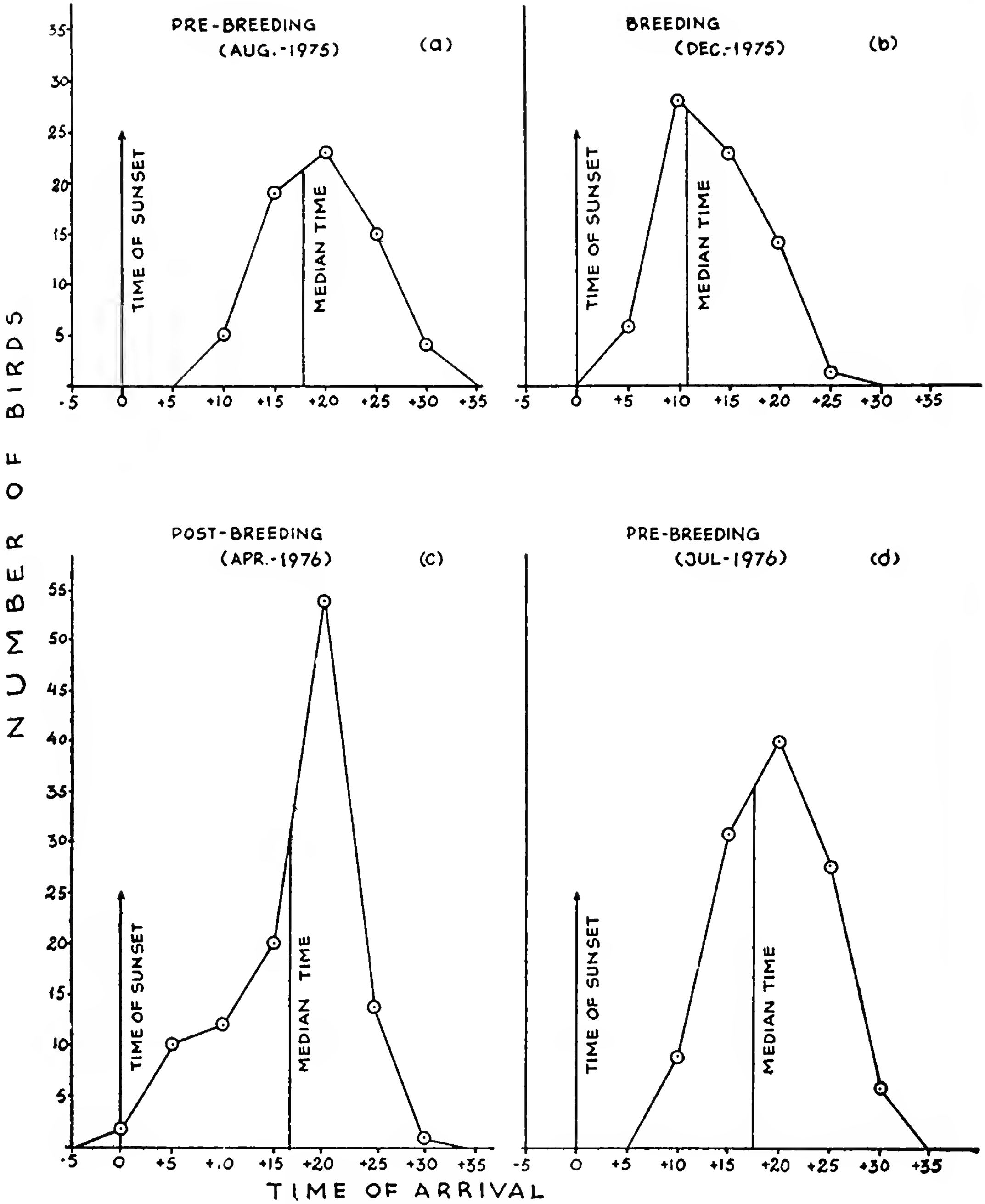

Fig. 6. Variations in time of arrival of kites at roost R-I in relation to the time of sunset in different seasons.

iii) In all the seasons, the time of arrival of the last kite is between 30 and 35 minutes after sunset.

iv) The median time of arrival of kites (i.e. the time at which 50% of the total roosting population arrives) in the breeding season is earlier (+11.0 minutes) as compared to post-breeding and pre-breeding seasons (+16.5 and +17.5 minutes respectively).

v) The total time span of arrival of the kites is more (35 minutes) in the post-breeding season as compared to the remaining two seasons (25 minutes in each).

Pre-roosting display: Generally, in all the months Pariah kites gather above the roost and manoeuvre for sometime in the sky before coming down and settling at the roost. This gathering is in loose formation. However, during the pre-breeding season they exhibit peculiar pre-roosting displays. The intensity of these displays is much more towards the end of August and in early September. In this pre-breeding season, number of kites start gathering about 5 to 15 minutes before sunset and fly above the roost in a tight formation. The displaying flocks, comprising of 50-250 birds ascend high up in the sky by circling around and round, then descend slowly just over the communal roost and again ascend. This process is repeated a number of times. Such a displaying flock appears as a cylindrical column from a distance. After a period of about 6 minutes, the displaying flock slowly settles down at the roost.

Sometimes, the kites which have already roosted, suddenly take off from the roost without making any noise, and take a complete round of about half a kilometre radius over the roost. Each kite makes a number of circles around itself while following this circular course. Such displays were more pronounced at roost R-IV. Many times, kites perform semi-circular displays and return to the roost mostly in pairs. The distance between such pairs was found to be between 0.7 and 2.7 metres. All these types of pre-roosting communal displays are performed silently.

During July to September of the years 1978 to 1983, the Pariah kites were found to gather in large numbers at roost R-IV when they showed these pre-roosting displays.

The ultimate function served by these aerial pre-roosting displays is unknown. It is assumed that they are related to pair formation and communication of information regarding preparation for return journey to their original localities. This could be clearly noticed at roost R-IV where the kites assembled in large numbers only during the pre-breeding season (coinciding with the monsoon) and showed such pre-roosting displays. From the commencement of the breeding season in October almost all kites abandoned this roost coinciding with a marked decrease in the total population of Pune city.

Acknowledgements

We are grateful to the Director, Zoological Survey of India, Calcutta for the facilities provided and to Prof. Madhav Gadgil of Indian Institute of Science, Bangalore for stimulating this investigation. We are thankful to Dr. V. G. Vaidya, M.A.C.S. Research Institute, Pune for his valuable suggestions. We also wish to thank Mr. P. W. Garde, Artist of Zoological Survey of India, Pune, for his skillful rendering of the diagrams.

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ON THE EXPORT OF FROG LEGS FROM INDIA

HUMAYUN ABDULALI[1]

(*With two plates & a text-figure*)

This is a revised version of the report submitted to the Indian Council of Agricultural Research in June 1979 under their 3-year project No. 12-15/73-PP entitled "Determination of Ecological Disturbances in Agricultural and adjoining lands by the removal of *Rana tigrina* and *Rana hexadactyla* for export."

It appears to be established that the frog plays an important part in the ecological cycle around the rice field and this is confirmed by an inquiry among villagers. The 15 tables covering its restricted breeding season, its growth, its readiness to breed in the year after hatching and its food at different ages and seasons etc. add new information to what is known. The small frog feeds largely on insects which have gathered together in numbers. Crabs which are harmful to rice in different ways form a large part of its diet when larger. It is held that the earning of Rs. 12 crores (in 1981) by the export of frog legs is more than offset by the use of chemical pesticides which apart from the cost, have deleterious side-effects yet largely unknown. The business is ecologically and economically unjustified, and the inhuman cruelty involved has aroused protests both in India and abroad.

Having worked as an exporter of raw and waste material for many years (with an amateur interest in natural history for a longer period) I was surprised in 1962 to notice in the Daily List of Exports issued by the Customs authorities that shipments of frog legs were going out from Bombay.

While we had all heard of French epicures eating frog legs, what immediately struck the naturalist was the very obvious fact that the removal of large numbers of frogs from the wild would eliminate an important destroyer of insects and increase the damage being done to our cultivation.

This was of particular importance to the Bombay area where the main crop is rice in wetlands and where the large Bull Frog (*Rana tigrina*[2]) was abundant. This animal was common in gardens and near residences and was also used for dissection in the zoological departments of the Bombay University. Its large gape and the fact that rats, birds and snakes were occasionally found eaten by them, led to a popular belief that it ate its own weight of food every day.

3-4000 tons of frog legs were exported from India every year. The export of 3000 tons meant, it was surmised, the destruction of at least 6000 tons of frogs which would have eaten the same quantity of insects or other animal food every day i.e. 6000 × 90 days of monsoon = 540000 tons! What tonnage of insecticides would be required to off-set the removal of this controlling force, and at what cost?

Letters to the newspapers and to Government Departments produced no response. On 20th October 1969 I attended the opening of the Karnala Bird Sanctuary (which had originally been suggested by BNHS) by the late Shri Naik, then Chief Minister of Maharashtra.

1 75 Abdul Rehman Street, Bombay-400 003.

2 Spelt as *tigerina* in the original description — Eds.

Shri Naik made a speech regarding the protection of birds and animals and referred to the diminution in their numbers. When he had finished, a resident of the neighbourhood stood up and referred to the commercialisation of frogs and said the time was soon coming when no frogs would be left and a benefactor of the farmer would be lost. I seized the opportunity to refer to the problem in greater detail and the minister asked me to make a representation to him which he would arrange to have examined and followed up.

A representation was made almost immediately and finally after several reminders, during which time the problem was passed from hand to hand, I received a letter from the Department of Fisheries that as the frog was not a fish, they were unable to handle the inquiry.[3]

Thus the matter lay for several years until I was flying to Delhi and in the course of a conversation with the gentleman seated next to me, discovered that he was Dr. D. N. Srivastava, Asst. Director General (P.P., Indian Council of Agricultural Research (I.C.A.R.). I told him about the export of frogs and the likely repercussions on agriculture in the Konkan and other places, and he asked me to undertake a research study. I said my business did not give me much spare time, and such as I had was devoted to birds. He had however got interested and offered to pay for assistants to work under my supervision. Telephone calls from Delhi and the keenness shown by him, finally prompted me to act as Principal Investigator for a 3-year research project (I.C.A.R. Project No. 12-15/73-PP) entitled "Determination of ecological disturbances in agricultural and adjoining lands caused by the removal of *Rana tigrina* and *Rana hexadactyla* for export" routed through the Bombay Natural History Society.

[3] In subsequent years and currently, frog legs are included in statistical figures for export of Marine Products.

Dr. A. G. Joshi, Ph.D. and Shri M. M. Hosalkar, M.Sc. were appointed as Scientist and Research Assistant, and I must clarify at the outset that though I retained an interest in the project and kept overall check upon the work, it was not possible to give it all-time personal attention and credit must go to these two workers for having continued working on a subject with which they were not familiar, often under trying conditions.

Considering the circumstances under which the project was undertaken, and the time and personnel available, no detailed plans of activity had been prepared and the general programme of activity was allowed to develop concurrently with the actual work and findings and the report after 3 years breaks up under the following headings :-

1. General remarks.
2. Field notes — habits and habitat.
3. Population dynamics, breeding and growth.
4. Sex ratios
5. Food

5a. Food outside Konkan

6. Notes on *Rana hexadactyla*
7. Inquiry among farmers regarding ecological consequences of frog removal.
8. Experimental efforts in the field.
9. Export Regulations and Conservation.
10. Conclusions.
11. Acknowledgements.
12. Eclectic Bibliography.

1. General Remarks

Based in Bombay, the work was primarily restricted to the adjoining rice-growing districts of Thane and Kulaba (now Raigadh)

which have an average annual rainfall of about 1875 mm. (75 inches) restricted to the south-west monsoon, June to September. The main work is concerned entirely with *Rana tigrina,* for this is the only large frog of the area. *Rana hexadactyla* has only been doubtfully recorded and is certainly not large or numerous enough (here) to be of commercial or ecological significance here. Unless otherwise specified or evident from the context, the term "frog" will, in the following notes, apply to *R. tigrina* only.

The first few trips into the field, mostly at night, drew forcible attention to the fact that the animal was not as abundant as it had been a few years ago, and the number to be seen or captured on every trip, sometimes only 2 or 3, would not provide enough data or opportunity for the study of their food, as had been initially envisaged. More attention was, therefore, given to material brought to the cutting centres where the frogs were processed for the foreign markets.

Again with some experience it was found that the bulk of the material received in Bombay was brought over considerable distances, even from Gujarat, and transport having taken several days, the stomach contents were partly or wholly digested, making them difficult or impossible to identify. For this reason, the bulk of the material examined was obtained from the frog-processing factory at Karjat,

TABLE 1

ANNUAL EXPORTS OF FROG LEGS AFTER 1963

Year	Quantity of frozen frog legs exported. Tonnes	Minimum* quantity of frogs killed in tonnes.	Foreign Exchange earned. Rs.	Export Rate Rs./Kg. f.o.b.
1963	514.00	1542.00	3192000	6.21
1964	332.00	996.00	1650000	4.96
1965	443.00	1329.00	2604000	5.88
1966	557.00	1671.00	5576000	10.01
1967	786.00	2358.00	8817000	11.21
1968	425.31	1275.93	4891310	11.50
1969	854.37	2563.11	11889563	13.91
1970	2544.87	7634.61	32899364	12.92
1971	1451.14	4353.42	13774273	9.49
1972	1823.48	5470.45	21709398	11.90
1973	2697.60	8092.80	44878893	16.63
1974	1453.96	4361.90	28651727	19.70
1975	1317.48	3952.45	27982525	20.70
1976	3169.88	9509.65	77969621	24.59
1977	2834.20	8502.61	65966878	23.27
1978	3570.00	10710.00	84300000	26.36
1979	3764.00	11292.00	87200000	23.15
1980	3095.00	9285.00	73200000	23.06
1981	4368.00	13104.00	119600000	27.37
1982	2271.00	6813.00	55453406	24.40
1983	3658.00	10914.00	—	—

* excluding spoilts & rejects.

Kulaba district, where supplies were mostly from the surrounding countryside, and often available for examination within a few hours of capture.

These difficulties were to some extent overcome at least on an experimental basis by working over the paddy fields of the Agricultural Research Centre of the Konkan Krishi Vidyapeeth at Karjat, where the fields are protected by watchmen and had not yet been cleared of frogs. Their capture no doubt immediately affects the population. On a trip over about 20 hectares of these grounds, 23 frogs were collected on the first night, 19th September 1977, Thereafter on subsequent visits, the number available dropped and on the 5th visit (20 October) only 6 were obtained. According to the Zippin (1956, 1958) Method, this population works out at 5.2 per hectare or 1364 per square mile. As indicated earlier, no statistical information is available but there can be no doubt that this is only a fraction of what existed a few years ago. This is also confirmed by local opinion dealt with under part 7 of this report.

158 field trips, including 55 at night, were made to 28 different places.

Unless otherwise specified, the following observations are from notes and data retained in the course of this study. Attention is drawn to instances where our findings differ from those of earlier workers. There appears to be no doubt that the number of frogs has declined and only a few were seen in places where we had expected to see many. This rarity refers to frogs which were large enough to be of commercial value, for occasionally large numbers of small non-commercial size were seen.

2. Field notes — habits and habitat

Rana tigrina is essentially a frog of wet places, being found on the edges of small ponds and lakes, in permanent and temporary pools and puddles, in paddy fields and in the marshes formed during the monsoon. They are not ordinarily found actually swimming in water and their occurrence in wells and tanks with vertical stone sides is accidental or due to introduction by man. It is entirely carnivorous and most of its food is found in and near water, usually by sitting in a suitable place and waiting for its prey to appear. Near human habitations, it visits dung and garbage heaps where insects are found and which may be some distance from water. During the day, they usually secrete themselves in holes in the ground, under cover of logs and stones, or grass and other vegetation.

After the monsoon when the pools and tanks start drying up, there is a concentration at the restricted puddles. A stage later the frogs enter cracks and crevices as well as crab-holes, rat-holes and other cavities in the ground, where they normally disappear from human view and lie dormant until the break of the next monsoon. The process of aestivation appears to be controlled entirely by the desiccation of its habitat and a small proportion in suitable ecological conditions may remain active throughout the year. But the commercial collecting of frogs in the Konkan ends in about November, when most frogs have disappeared.

In Gujarat, Bengal and Andhra Pradesh, a considerable amount of collection continues even later, for the locals dig them out of their aestivating holes where many may often be found together.

Collecting in Tamil Nadu and Kerala continues after the monsoon but this is due to (a) the double monsoon, (b) a larger amount of irrigation, and (c) the fact that three other species *Rana hexadactyla, Rana crassa* and *Rana cyanophlyctis*, of different habits and habitat are also captured for the same purpose.

Incidentally, the live frog is purchased at

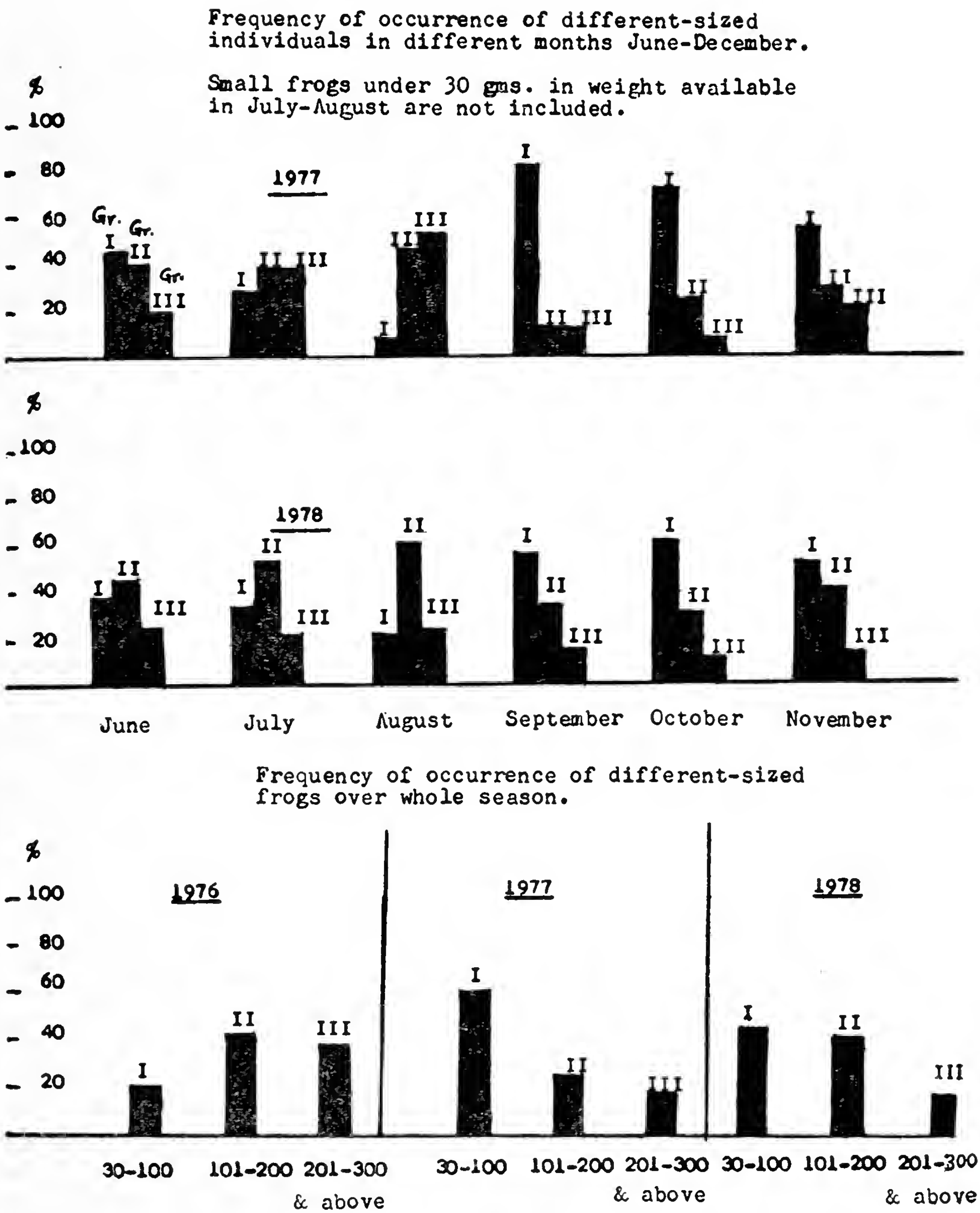
Frequency of occurrence of different-sized individuals in different months June-December.
Small frogs under 30 gms. in weight available in July-August are not included.
%
100
80
60
40
20
1977
Gr. I
Gr. II
Gr. III
I
II
III
%
100
80
60
40
20
1978
I
II
III
June
July
August
September
October
November
Frequency of occurrence of different-sized frogs over whole season.
%
100
80
60
40
20
1976
1977
1978
I
II
III
30-100
101-200
201-300 & above

Fig. 1.

TABLE 2

FREQUENCY OF OCCURRENCE, IN PERCENTAGES, OF DIFFFERENT WEIGHTS AND SIZES OF FROGS IN DIFFERENT MONTHS OF 1977 & 1978

Month	1977	1978	1977	1978	1977	1978
	Group I		Group II		Group III	
	30-100 gm or 70 mm. - 100 mm.		101-200 gm. or 100 mm - 120 mm.		201-300 gm. and above 120 mm. and above	
June	41.20	36.30	39.00	40.90	19.80	22.80
July	26.90	33.30	36.55	49.70	36.55	19.00
August	5.25	20.00	43.15	58.00	51.60	22.00
September	80.90	54.00	9.80	32.00	9.70	14.00
October	70.15	60 00	23.95	30.00	5.90	10.00
November	52.50	50.00	28.30	38.00	19.20	12.00

prices between Rs. 2/- and Rs. 4.50 per kg. As only one-third is recovered as finally processed legs, the base cost of the legs is Rs. 6/- to Rs. 13.50 per kg. while current (1976-79) F.O.B. prices are between Rs. 25/- and Rs. 32/- per kg. This leaves the difference as the exporter's profit, less the actual cost of processing and shipping.

3. Population dynamics, breeding & growth

The frequency of size variation in different months was analysed (Table 2 & Figure 1). This shows a simple population structure. At the beginning of the monsoon, tiny individuals below 50 grammes were totally absent, while frogs of the larger sizes were common. Later in July and August, tiny frogs were available and there was a steady increase in size in subsequent months until they attained 60/80 grammes (75-90 mm.) i.e. almost adult size, by December.

The number of tiny frogs seen in different years varied widely, and this must be due mainly to the amount of water available particularly at the tadpole stage. Apart from heavy mortality due to desiccation, excess rain can flood the pools and wash away large numbers. Only a small proportion of the eggs/tadpoles grow to maturity.

The sexual organs in both males and females were found enlarged by mid-May, though the actual courting and pairing did not take place until the break of the monsoon and lasted only a few days. At this time, distinct sexual dimorphism is exhibited by the adults, the males having (a) a dark lemon yellow colour above, (b) dark bluish green vocal sacs, and (c) enlarged nuptial pads on the forelimbs. All three characters disappear very soon. Character (a) i.e. the dark lemon yellow colour of the male comes on and disappears frequently and very rapidly, being controlled by physiological processes linked with their seasonal sexual condition/activity — some individuals packed closely in bags with hundreds of others were found to be yellow on 8th May. At this time all adult males had enlarged gonads, increasing from the dormant size of 10-15 mm. × 1-1.5 mm. to 10-25 mm. × 3-4 mm. in thickness (Table 3). The females were full of

TABLE 3

OBSERVATIONS ON SIZE AND COLOUR OF GONADS OF *R. tigrina* IN DIFFERENT MONTHS

Month	Male	Female
April	Testes light yellow and small	Ovary dark yellow with black spots, slightly enlarged in size.
May	Testes dark yellow and enlarged in size	Ovary fully developed and matured with numerous eggs.
June	Testes dark orange-yellow; greatly enlarged, length 10-25 mm., diameter 3 to 4 mm.	As in May. Weight of ovary varied from 20 to 100 gms. and consisted of 1500 to 10000 eggs each. Later, many ovaries spent and with a few undeveloped eggs.
July	Testes dark yellow, and reduced in size	All ovaries spent and with a few undeveloped eggs.
August	Testes light yellow and greatly reduced 10 to 15 mm length and 1 to 2 mm diameter	Ovary small and whitish.
Sept.	Testes light yellow or whitish	Ovary small, soft and light yellow.
Oct.	Testes whitish yellow and very thin	Ovary small without any black spots; light yellow or white.
Nov. to March	— do —	— do —

mature ova weighing 20 to 100 grammes according to the size of the female, each ovary containing 1500 to 10000 eggs.

The minimum size of both males and females at maturity is about 65 grammes (85 mm. from snout to vent).

The largest individual handled was a female of 640 gms. though we were informed that they grew upto one kilogram.

The breeding was seen to commence immediately after the first showers i.e. end May or early June and the gonads were found to be completely spent by the end of June, most breeding being completed by 25th June. There is no evidence of this frog breeding more than once during the season.

Males and females were seen in amplexus during the day as well as at night. Such pairing usually takes place in shallow stagnant water in or near small ponds rather than in large lakes and streams. Even when deliberately disturbed in this condition, they moved away together. The eggs are exuded in a continuous stream which is finally left as a clump or heap in the water. The process may last for several hours.

McCann (1932, 1940) has written in some detail about the breeding and other habits of this species which was then available in every garden around Bombay and thrust itself upon the attention of anybody with the most casual interest in natural history. More detailed accounts of courtship and mating are included in his papers and with small variations the present study confirms his observations, and reference is made to his notes only when there appears to be any difference of opinion or record. He refers to several scores of male frogs croaking together and making a deafening noise. Today, it is unlikely that any such

number would be found together anywhere within "striking' distance of a collecting centre.

In captivity the female may release its eggs in the absence of the male. They may also be exuded when held by the waist between thumb and finger.

For growth of tadpoles/young frogs see Table 4.

The eggs hatched in about 24 hours and the tadpoles developed into tiny frogs, yet with rudimentary tails, in another 4 weeks.

No actual studies were made but the tadpoles appeared to feed largely on the scrapings from the weeds growing in water, and in their absence, on the micro-organisms, dead and alive, both sedimental and suspended in stagnant water. McCann (loc. cit.) fed them on pieces of mutton suspended in water. Kamat, N.D. (1962), refers to unidentified tadpoles at Kolhapur, Maharashtra feeding on several species of algae but *not* (1) *Chara vulgaris*, (2) *Cladophora callicoma*, (3) *Nostoc sphaericum* and (4) *Pithophora oedogonia.*

From 21st July to 15th December, 8 batches

TABLE 4

GROWTH OF TADPOLES AND YOUNG FROGS (*R. tigrina*) FROM THANE REGION

Date	Stage I*	Stage II	Stage III	Stage IV	Stage V
21-22 June	Breeding pairs observed				
26 June	very small tadpoles seen				
4th July	60	40	3	—	—
10th July	24	16	15	12	3
16th July	10	15	30	40	13
21st July	5	4	6	20	70

* Stage I — small tadpoles (no limbs) 18-22 mm
Stage II — big tadpoles (no limbs) 26-28 mm
Stage III — tadpoles with hind limb 40-47 mm
Stage IV — tadpoles with hind and fore limb 45-51 mm
Stage V — tiny frogs with rudimentary tail; 20 mm. overall, snout to vent.

TABLE 4a

GROWTH OF YOUNG FROGS

Date	No. of frogs	Total length (mm) and range		Total weight (gm) and range	
21st July	10	55	(40-60)	2.5 gm	(2-3)
27th July	10	95	(80-100)	5.8 gm	(5-8)
5th August	15	125	(110-130)	10.5 gm	(9-13)
21st August	6	135	(130-140)	20.7 gm	(15-25)
15th Sept.	11	155	(145-160)	30.80gm	(25-40)
15th Oct.	10	175	(170-180)	46.50gm	(40-50)
15th Nov.	6	186	(180-200)	54.50gm	(50-60)
15th Dec.	15	198	(180-200)	65-90gm	(60-80)

of small frogs were collected in one small marsh near Thane. Table 4a shows the periodic increase in weight and size. It would appear that tadpoles hatched in June/July reach an average weight of 65.9 grammes by December.

At the commencement of the following season i.e. in June, the smallest individuals were 65 grammes in weight and 85 mm. from snout to vent and had mature testes and ovaries. McCann (loc. cit.) refers to frogs of this size being found in amplexus but says that they were "non-breeding" and had their testes 10 mm. The only explanation can be that he has omitted to allow for the thickness of the testes which is the real indication of their maturity and only compared the length, which may be the same in small breeding and large non-breeding males.

It will be noticed that the frogs actually breed effectively only at the break of the monsoon which may be any time between 15th May and 25th June.

The above data indicates that all individuals existent at the beginning of the season are ready to breed, those in Group I having hatched and developed in the previous season and attained a weight of 65 grammes. At this rate of growth the largest individual weighing 640 grammes would be 10 years of age. It has been held that *Rana tigrina* attains maturity after several years, but even if it breeds after one year, (as per our recordings) there can be no doubt that it would do so for several years afterwards, while it continues to increase in weight and size.

4. Sex Ratios

1186 frogs were sexed in 1976. In 4 of the 6 size-groups there were more females than males; only among the largest, the number of females suddenly dropped to 35.3%. A monthwise statement of 729 frogs of different sizes was retained from June-November 1977. Here also the females were slightly more numerous in the earlier months with the males catching up at the end. The figures for June show 58.5% males but this may be due to their bright colours and greater visibility at this period (Table 5 & 6).

5. Food

This carnivorous animal is unselective and except perhaps for a few unpalatable items, feeds on whatever is available, waiting in suitable places for the prey to approach it. Its feeding places may be largely grouped as follows: (a) banks of rivers or brooks, (b) edges of ponds and lakes, (c) paddy field embankments, (d) heaps of garbage and organic wastes, (e) drying ponds, puddles and rice fields, (f) under electric lights attracting phototropic insects and (g) any other places where insects or their larvae are found in numbers.

Tables 7-7d cover the variety and proportion of different foods taken by frogs of different sexes, size-groups and periods in the Bombay Konkan. It will be immediately evident how widely the food can and does vary, but the larger frogs are almost entirely subsistent upon crabs of 3 species, all of which are recognised pests in rice fields, damaging the bunds and destroying seedling rice (see Jabir Ali 1955).

All its food is captured on the ground or by jumping upon it on the surface of water from land. There is no evidence of any animal being pursued and captured under water, the reflex action of the nictitating membrane presumably preventing it from seeing anything once its eyes are submerged. Though essentially an inhabitant of wet grassland, it has to leave the more heavily grassed areas and come out into the open to see its prey. Its feeding is almost entirely at night, though its courting and

TABLE 5

SEX AND SEX RATIOS OF FROGS OF DIFFERENT SIZE GROUPS EXAMINED IN 1976

Sr. No.	Size group	Total	Male	Female	Male:Female ratio
1	30–100 gms	212	93	119	43.87:56.13
2	101–200 gms	511	217	294	42.47:57.53
3	201–300 gms	303	143	160	47.20:52.80
4	301–400 gms	89	41	48	46.07:53.93
5	401–500 gms	54	27	27	50.00:50.00
6	501–upwards	17	11	6	64.71:35.29
		1186	532 (44.86%)	654 (55.14%)	

TABLE 6

SEX AND SEX RATIOS OF DIFFERENT SIZE GROUPS JUNE TO NOVEMBER 1977

Month	30-100 gms.		101-200 gms		200-300 and over		Total		Total	Percentage
	♂	♀	♂	♀	♂	♀	♀	♂		♀ ♂
June	9	8	8	8	7	1	24	17	41	58.53:41.47
July	6	8	9	10	8	11	23	29	52	44.23:55.77
August	3	2	14	27	22	27	39	56	95	41.05:58.95
Sept.	88	94	13	9	13	9	114	112	226	50.44:49.56
Oct.	83	84	32	25	8	6	123	115	238	51.68:48.32
Nov.	24	28	14	14	10	9	48	51	99	48.48:51.52
Total	213	224	90	93	68	63	371	380	751	
	48.74:51.26		49.18:50.82		51.91:48.09		49.40:50.60			

mating may be carried out in broad daylight (see McCann, loc cit.). Wadekar (1963) refers to more food being taken on moonlit rather than on dark nights. Movement attracts attention and the first reaction is to jump upon and swallow its prey, all in a single movement. This has often led to the frog catching and attempting to swallow, not always successfully, snakes and other items, too large for it. This habit no doubt accounts for the several notes in the Journal of Bombay Natural History Society, referring to the frog swallowing snakes, birds, rats etc.

Movement may be detected as far as 15′ away, and then approached in a series of 3 or 4 bounds, the last leap being made on to its prey which may be on or some distance off the ground.

The fore legs are used to push into the mouth any item which it may not be able to swallow completely. The occurrence of paper, bits of grass, leaves and fruit, and even stones,

TABLE 7

FREQUENCY OF OCCURRENCE OF DIFFERENT ITEMS IN STOMACHS OF FROGS OF DIFFERENT SIZES AND SEXES (1976)

	30 to 100 gm		101 to 200 gm		201 to 300 gm		301 to 400 gm		401 to 500 gm		501 to 600 gm & upwards	
Nos. of frogs	119 ♂	93 ♀	294 ♂	217 ♀	160 ♂	131 ♀	48 ♂	41 ♀	27 ♂	27 ♀	11 ♂	6 ♀
Food item												
Crab	20	14	277	194	137	127	44	36	24	27	11	6
	16.66%	14.84%	94.21%	89.40%	85.62%	96.94%	91.66%	87.80%	88.88%	100%	100%	100%
Insect	80	55	75	46	30	28	5	4	1	5		
	66.5%	58.30%	25.51%	21.19%	18.75%	21.37%	10.41%	9.75%	3.70%	18.51%	0	0
Insect larvae	47	28	18	5	7		2	2				
	39.15%	29.68%	6.18%	2.30%	4.37%	0	4.10%	4.87%	0	0	0	0
Earthworm	18	6			1							
	15%	6.36%	2.68%		0.6%	0	0	0	0	0	0	0
Snails	5	4	6	4	4	3		0	2	1		
	4.16%	4.12%	2.04%	1.84%	2.5%	2.29%	0	2.43%	7.40%	3.70%	0	
Grass & veg.	37	25	77	53	27	33	11	7	7	3	1	
	30.80%	26.25%	26.19%	23.00%	16.87%	25.19%	22.91%	17.07%	25.92%	11.11%	9.1%	0
Stones & earth	13	5	33	17	20	13	6	1	3	1	2	
	10.80%	5.3%	11.22%	7.83%	12.50%	10%	12.5%	2.43%	11.11%	3.70%	18.2%	0
Unidentified	35	33	56	39	31	22	9	6	5	2		
	29.80%	34.98%	19.04%	17.97%	19.31%	16.79%	18.75%	14.63%	18.51%	7.40%	0	0

TARLE 7a

FREQUENCY OF OCCURRENCE OF DIFFERENT ITEMS IN *Rana tigrina* & *Rana hexadactyla* OF DIFFERENT SIZES

Year & locality	Frog Group	Crab	Insect	Insect larvae	Earth worm	Snail	Centi-pede	Milli-pede	Spider	Scor-pion	Prawn	Fish	Frog	Lizard	Snake	Bird	Rats & mice
1976	*Rana tigrina*																
Karjat	Group I	15.75	62.40	34.41	10.66	4.14											
(Konkan)	II	91.80	23.35	4.24	2.68	1.94	0.40	—	0.66	0.15	—	0.15	0.46	—	0.40	0.46	0.85
	III	93.86	10.31	1.66	0.10	2.29											
1977																	
Konkan	Group I	13.33	62.70	26.66	44.00	6.20											
	II	47.32	41.20	16.00	8.00	4.00	2.60	1.65	3.50	0.28	1.10	0.80	3.80	0.27	0.27	0.14	0.70
	III	100.00	15.60	5.20	0.00	1.04											
1978																	
Konkan		36.25	53.40	24.81	0.72	7.66	2.04	0.12	0.48	1.80	0.48	0.36	3.52	0.48	0.12	0.24	2.04
Karwar		9.00	51.00	29.00	7.00	10.00	—	4.00	2.00	—	2.00	7.00	8.00	—	—	—	1.00
Hyderabad		56.14	49.12	5.26	3.50	7.00	3.50	—		5.26		1.75	5.26	—	3.50	—	1.75
Trivan-drum & Madras	*R. hexa-dactyla*	8.00	72.00	8.00	2.00	4.00	4.00	—	2.00	—	—	2.00	8.00	—	2.00	—	—

TABLE 7b

SEASONAL VARIATIONS IN STOMACHS CONTENTS OF FROGS (1977) (PERCENTAGES)

Gr. & Month		Crab		Insect		Insect larvae		Earthworms	
		♂	♀	♂	♀	♂	♀	♂	♀
June & July	I	9.10	—	45.45	50.00	18.80	12.50	36.36	62.50
	II	33.00	33.00	66.66	66.66	33.33	10.10	—	44.44
	III	100.00	100.00	—	—	—	—	—	—
August	I	—	50.00	100.00	50.00	—	—	—	—
	II	92.80	74.08	21.40	44.44	21.40	22.22	—	—
	III	100.00	100.00	17.64	20.00	4.54	8.00	—	—
September	I	8.57	8.53	94.28	69.51	54.28	30.48	94.28	57.31
	II	76.90	87.50	23.07	62.51	7.70	25.00	7.70	12.50
	III	100.00	100.00	16.66	—	—	—	—	—
October	I	9.23	4.22	46.15	50.70	16.92	26.76	44.61	28.16
	II	87.50	91.66	33.33	29.16	12.50	12.50	8.33	16.66
	III	100.00	100.00	16.66	33.33	—	—	—	—
November	I	52.17	48.00	52.17	60.00	12.50	4.00	—	—
	II	42.50	25.00	64.25	83.35	7.14	33.33	—	8.33
	III	100.00	100.00	28.57	10.10	14.28	10.10	—	—

TABLE 7c

SEASONAL VARIATION IN STOMACH CONTENTS OF FROGS 1978 (PERCENTAGES)

Month	Crab	Insect	Insect larvae	Earth worms	Snail	Millipede / centipede	Prawn	Spider / Scorpion	Fish	Frog	Snake	Rat / mice
June & July	30.26	47.36	14.47	2.63	9.21	— / 3.93	1.31	1.31 / —	—	1.31	—	1.31 / —
August	37.50	46.42	28.57	3.57	7.14	— / 3.57	1.75	3.57 / 3.57	—	5.35	—	— / —
September	28.26	62.60	28.26	—	8.26	— / 3.90	0.43	— / 3.90	0.43	3.43	—	0.43 / 1.24
October	48.43	53.36	31.83	—	9.41	0.45 / 0.45	—	— / 0.80	0.89	4.48	0.43	1.35 / 0.89
November	34.17	48.10	17.29	0.84	5.06	— / 0.84	—	— / 0.84	—	3.37	—	2.53 / —

TABLE 7d

FREQUENCY OF OCCURRENCE OF DIFFERENT ITEMS IN STOMACHS OF 700 FROGS OF DIFFERENT SIZES CAPTURED IN FIELD, IN 1976 & 1977

Year		Stomach contents as % age of body wt.	Crab	Insect	Insect larvae	Earth worms	Snail	Millipede and Centipede	Prawn	Spider	Fish	Frog	Snake	Rat
1976	I	3.93	5.64	79.0	45.14	13.70	2.41	2.41	—	1.58	—	—	—	—
	II	3.47	51.85	44.44	22.22	3.70	3.70	—	—	—	—	—	—	7.40
	III	3.78	76.47	41.17	11.76	—	—	5.85	—	—	—	—	—	—
1977	I	3.46	6.87	82.50	38.12	52.50	4.37	3.74	1.25	4.37	1.25	1.85	0.62	0.62
	II	3.46	45.45	47.72	20.45	13.63	5.46	—	2.73	2.73	5.46	2.73	—	—
	III	3.60	80.00	20.00	16.00	—	4.0	—	4.0	—	—	4.0	4.0	—
1976	I	5.07	Relating to material obtained at cutting centres only.											
	II	7.23												
	III	7.12												
1977	I	5.33												
	II	4.24												
	III	6.04												

in their stomachs is no doubt due to their being pushed in accidentally, and remaining undigested.

3624 frog stomachs have been examined and analysed. These include 700 taken in the field and the rest from cutting centres, mostly at Messrs Jadhav & Dabhia's at Karjat.

In both instances the bulk of the material is from the Bombay Konkan and, as explained earlier, our activities were restricted to this place because the captured frogs were brought in more quickly and the food was found less digested. Though unsupported by experimental evidence, it did appear the digestion was abnormally slowed by capture and the attendant treatment.

Tables 8 and 9 (pp. 363/4) give in greater detail the items identified. The material includes Annelids (earthworms), Centipedes, Millipedes, Arachnids (scorpions and spiders), Crustaceans (crabs and prawns), insects and insect larvae of many kinds, Molluscs (snails) and vertebrates including fish, frogs and toads, lizards and snakes, birds and mammals (rats and shrews).

[4]Some 400 tubes containing *Coleoptera* (beetles) are still unidentified with the Zoological Survey of India but the material was weighed and is included in the calculations and discussions relating to the quantitative analysis of food.

It is evident that the quantity of crabs eaten increases with the size of the animal until it constitutes almost 100% of its food. The main requirement of the food of the species is its availability and insects of all sizes, their larvae, earthworms, and other items are accepted as and when numerically sufficient.

[4] This list has now, September 1984, been received (the original sent in February 1983 having been lost in the post) and is included as supplementary to Table 9.

It has not been possible to obtain any earthworms in a condition good enough to permit identification even down to genus, but it is worth noting that in 1977 as many as 44% of stomachs of Group I i.e. animals of the smaller sizes, contained earthworms, followed by only 8% in Group 2 and none in Group 3. In the previous year the same figures were 10.66, 2.68 and 0.1.

Crabs, earthworms, insects and insect larvae account for about 90% of their food both in terms of weight and frequency. Most of the other items can be treated as sporadics being taken more or less indiscriminately as and when available.

The food of a few specimens taken during the short trip to Karwar, Hyderabad. Trivandrum and Madras, has also been similarly tabulated and it will be found that there is no appreciable difference in the general picture.

The ecological importance of the many species of insects has not been determined but the fact that the frog takes advantage of every concentration or getting together of individuals of the same species, is a good index of the apparent efficacy of their control on their numbers.

Curiously, the weight of the food in Table 7d (p. 361) is less than in the material collected at the cutting centres but this may be due to one or more of the following reasons:

(1) At the cutting centres, there was a general tendency to pick and examine the stomachs which appeared to be full rather than the empty ones,

(2) the rough handling and transport may have arrested or slowed the digestive process and

(3) the supplies examined from Karjat were obtained mostly early in the morning, when the animals, having fed throughout the night, contained more food.

TABLE 8

LISTS OF ITEMS IDENTIFIED IN STOMACHS OF FROG (*R. tigrina*)

ARTHROPODA

I CRUSTACEA (crabs and prawns)

- *1. *Paratelphusa guerini* (496 stomachs)
- *2. *Paratelphusa jacquemontii* (133)
- *3. *Gecarcinucus jacquemontii* (201)
- 4. *Varuna litterata* (10)

II PRAWNS (14)

III INSECTS (see also Table 9)

COLEOPTERA (beetles)

1. SCARABAEIDAE — Melolonthinae (31)
   - Coprinae, *Onthophagus* sp.; *Catharsius* sp.; *Onitis* sp. } 118
   - Rutelinae — *Rhynyptia* sp. (180)
2. DYTISCIDAE — *Cybister* sp. (17)
3. CICINDELIDAE (23)
4. CARABIDAE — *Chlaenius* sp.), *Siagona* sp. } (52)
5. HYDROPHILLIDAE (39)
6. TENEBRIONIDAE — *Scleron* sp. (19)
7. BUPRESTIDAE — *Sternocera* sp. (7)
8. TROGOSITIDAE — (5)
9. CURCULIONIDAE — *Placocerus* sp. (23)
10. BRUCHIDAE (4)
11. CETONIINAE — *Chiloloba* sp. (9)
12. CHRYSOMELIDAE — *Heltica* sp. (5)
13. CERAMBYCIDAE — (4)

ORTHOPTERA

1. ACRIDIDAE — (LOCUSTIDAE) — *Hieroglyphus* sp. (81)
2. TETRICIDAE — *Scelimena* sp. (2)
3. GRYLLOTALPIDAE — *Gryllotalpa* sp. (52)
4. GRYLLIDAE — *Gryllopsis* sp., *Gymnogryllus* sp. (44)
5. TETTIGONIIDAE — *Sathrophyllia* sp. (3)

DERMAPTERA

1. LABIDURIDAE — *Labidura* sp., *Anisolabis* sp., *Forcipula* sp. } (52)
2. CARCINOPHORIDAE — *Euborellia* sp.

HETEROPTERA

1. NEPIDAE — *Laccotrephes* sp. } (9)
2. LYGAEIDAE — *Dieuches* sp. }
3. BELOSTOMATIDAE — *Belostoma* sp. (7)
4. CYDNIDAE — *Cydnus* sp. (4)
5. PENTATOMIDAE — *Podops* sp. (30)
6. REDUVIIDAE — (4)
7. DINIDORIDAE — *Aspongopus* sp. (3)

HYMENOPTERA

1. FORMICIDAE — *Camponotus* sp. (41)
2. MEGACHILIDAE — *Megachilla* sp. (4)

BLATTARIA

1. BLATTIDAE — *Periplaneta* sp. (15)

IV ARACHNIDA

1. Spiders (*Araneae*) (40)
2. Centipedes and Millipedes (57)
3. Scorpions (23)

V ANNELIDA (Earthworms)

1. *Pheritima* ? sp. (319)

VI MOLLUSCA (Gastropoda) (124)

- 1. *Ariophanta maderaspatana*
- 2. *Planorbis* sp.
- *3. *Pila virens*
- *4. *Vivipara bengalensis*
- 5. *Limnaea* sp.
- 6. *Melania* sp.

VII PISCES (Fish) (17)

VIII AMPHIBIA

1. *Bufo melanostictus* (3)
2. *Rana* spp. (70)
   - a. *Rana tigrina*
   - b. *Rana limnocharis*
   - c. *Rana cyanophlyctis*

IX REPTILIA

1. Snakes — (12)
   - a. *Typhlops acutus* (5)
   - b. *Xenochrophis piscator* (1)
   - c. *Boiga trigonata* (1)
2. Lizard (*Calotes* sp.) (7)

X AVES — (9)

1. PYCNONOTIDAE — *Pycnonotus cafer* (Redvented Bulbul) (11)

XI MAMMALS

- *1. *Rattus* sp. (26)
- 2. *Suncus* sp. (2)
- *3. Mice (7)

Figures in parenthesis indicate the number of specimens containing this species.
Groups marked * are accepted as injurious to agriculture. For insects see Table 9.

TABLE 9

	Insects identified	No. of insects/ No. of stomachs
I COLEOPTERA*		
1 COPRINAE (SCARABAEIDAE)	*Onthophagus catta*	4/2
	Onthophagus cervus	4/2
	Onthophagus bifasciatus	2/1
	Onthophagus unifasciatus	2/1
	Onthophagus sp.	6/1
	Onitis sp	4/3
	Catharsius sagax	11/9
	Catharsius molossus	9/8
	Catharsius sp.	1/1
*2 RUTELINAE	*Rhiniptia indica*	180/50
3 HYBOSORINAE	*Hybosorus orientalis*	29/20
4 DYTISCIDAE	*Cybister* sp.	10/8
*5 CARABIDAE	*Chlaenius* sp.	4/4
	Siagona sp.	8/7
6 HYDROPHILLIDAE		18/17
7 TENEBRIONIDAE	*Scleron reitteri*	10/8
*8 BUPRESTIDAE	*Sternocera* sp.	3/3
*9 CURCULIONIDAE	*Plococerus denticollis*	10/10
*10 CETONINAE	*Chiloloba acuta*	6/6
11 CHRYSOMELIDAE	*Haltica cyanea*	3/3
II HETEROPTERA		
12 BELOSTOMATIDAE	*Belostoma indicum*	6/6
	Diplonychus rusticum	5/5
*13 CYDNINAE	*Cydnus indicus*	1/1
*14 PENTATOMIDAE	*Esarcoris ventralis*	1/1
	Halyomorpha sp.	1/1
	Carbula sp.	3/1
	Nezara viridlula	1/1
	Podops bispinosa	1/1
*15 DINIDORIDAE	*Aspongopus obscurus*	1/1
16 LYGAEIDAE	*Dieuches* sp.	1/1
17 NEPIDAE	*Laccotrephes ruber*	8/5
	Laccotrephes griseus	3/1
	Laccotrephes sp.	2/2
III ORTHOPTERA		
*18 ACRIDIIDAE	*Hieroglyphus banion*	8/8
	Hieroglyphus sp.	15/14
	Scelimena harpago	1/1
	Tryxalis sp.	2/2
*19 TETRICIDAE	*Scelimena* sp.	2/2
*20 GRYLLOTALPIDAE	*Gryllotalpa* sp.	50/34
*21 GRYLLIDAE	*Gymnogryllus minor*	8/8
	Gymnogryllus sp.	4/4
	Gryllopsis sp.	2/2
	Gryllodes sigillatus	5/5
	Gryllodes sp.	3/3
	Gryllus bimaculatus	3/3
*22 TETTIGONIIDAE	*Sathrophyllia* sp.	3/3
IV DERMAPTERA		
*23 CARCINOPHORIDAE	*Euborellia annulipes*	3/3
24 LABIDURIDAE	*Labidura raparia*	11/10
	Anisolabis annulipes	2/2
	Forcipula sp.	2/2
V HYMENOPTERA		
25 FORMICIDAE	*Camponotus compressus*	19/16
26 MEGACHILIDAE	*Megachile lanata*	1/1
VI BLATTARIA		
*27 BLATTIDAE	*Periplaneta americana*	4/4

SUPPLEMENTARY LIST OF COLEOPTERA AS PER FOOTNOTE ON P. 362

Family	Name of the Species	No. of insects/ No. of stomachs
1) ELATERIDAE	*Heteroderes* sp.	1/1
	Lema sp.	1/1
	Attica sp.	1/1
2) DYTISCIDAE	*Hydaticus vittatus*	1/1
	Scandracottas dejeoni	2/2
	Cybister tripunctatus	1/1
3) TENEBRIONIDAE	*Gonocephalus* sp.	5/5
	Mesomorphus sp.	4/4
	Hematismus sp.	1/1
*4) CURCULIONIDAE	*Sipalus* sp.	1/1
	Xanthoprochilus sp.	1/1
5) SCARABAEIDAE (COPRINAE)	*Chiloloba acuta*	1/1
	Alissonotum piceum	1/1
	Onthophagus agnus	1/1
	Sisyphus longipes	1/1
	Catharius granulatus	1/1
	Onitus philemon	5/5
	Hybosorus sp.	5/5
	Holotrichia sp.	7/7
*6) MELOLONTHINAE	*Pachyrrhinadoretus rugipennis*	1/1
*7) CARABIDAE	*Scarites indicus*	4/3
	Pheropsophus catorei	3/3
	Clivina sp.	3/3
	Systolocranius linea	1/1
	Gnathophorus acutipennis	15/12
	Kareya edentata	13/2
	Abacetus sp.	3/2
	Pachytrachelus cribriceps	2/2

Groups marked * are accepted as injurious to agriculture.

TABLE 10

MONTHLY INCIDENCE OF NUMBER OF FOOD ITEMS IN SINGLE FROG STOMACHS (1977)

Group & month		1 item	2 items	3 items	4 items	5 & more
June & July	I	36.81	27.72	35.22	—	—
	II	44.44	41.66	13.38	—	—
	III	100	—	—	—	—
August	I	25	25	50	—	—
	II	53.22	36.63	10.25	—	—
	III	77.02	17.36	2.62	—	—
September	I	22.40	41.88	22.80	11.20	1.22
	II	81.20	18.80	—	—	—
	III	91.66	8.33	—	—	—
October	I	34.65	40.42	14.32	10.25	—
	II	46.25	33.25	14.58	6.25	—
	III	75.00	25.00	—	—	—
November	I	72.88	23.22	—	4	—
	II	50.00	23.80	19.64	7.73	—
	III	67.45	33.53	—	—	—
Total	I	34.80	37.69	17.55	9.14	0.80
	II	53.03	31.89	11.86	3.17	—
	III	78.34	19.51	2.17	—	—

Table 10 shows the number of different kinds of food items found in single stomachs at different times of the year. It will be noticed that a single item (one or more individual of the same speeies) forms a consistently large portion of the food of each individual, becoming more and more restrieted with the inerease in size of the frog.

For the same reason the sudden appearance of a large number of inseets of one species at one place brings in the frog as an active predator and implies that it is a most useful controller under such eonditions.

It will also be noticed that after the peak of the monsoon i.e. in September/October, the number of individuals in groups I & II which are found to contain more than one or two species increases, due either to their availability or to the absence of sufficient numbers of one kind.

Tables 11 and 12 cover the amount of food taken by individuals. It has generally been accepted in natural history circles in India that the Bull Frog takes its own weight of food per day, but in the eourse of this examination the gorged ones held only 20 to 30%, with the overall average of the different size groups, (after exeluding the empty stomachs) varying between 3 and 7%. This may possibly be due to their having been captured at different times of the day or night and at different stages of feeding and also the faet that some of the food must have been digested in the period in captivity.

The data regarding time, size, weight and nature of food for 1976 and 1977 was com-

TABLE 11

QUANTITATIVE FOOD INTAKE *i.e.* FOOD .S PERCENTAGE OF BODY WEIGHT (1976)

Size group	Maximum food in terms of % age of body weight		Average amount of food as % age of body weight		No. of frogs containing 3%		No. of frogs containing 3-6%		No. of frogs containing 6-9%		No. of frogs containing 9%	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
1-100	15.83%	22.50%	4.37%	4.63%	37	33	46	36	12	17	7	7
101-200	10.99%	14.10%	5.22%	5.48%	64	39	135	96	65	46	19	21
201-300	12.13%	29.04%	4.91%	5.39%	32	25	80	49	37	26	7	10
301-400	14.08%	15.80%	5.45%	4.65%	9	9	19	26	15	6	5	1
401-500	17.30%	17.50%	5.61%	5.78%	6	9	10	8	7	6	3	4
501 & upwards	10.32%	9.10%	6.28%	5.56%	2	1	3	2	4	3	2	1

puterised and Tables 13 and 14 show the results. The overall findings are similar to those found earlier i.e. the average stomach contents do not exceed 7% of the body weight, while the relative percentages (by weight) of crabs, insects, insect larvae and miscellaneous items are 82.7, 4.74, 3.85 and 8.7 respectively.

Reference has already been made to the fact that in 1977 the number of small-sized individuals was much greater and this reduced the percentage of the crab-eating population and increased that which fed on insects and insect larvae. The computer has also helped to confirm that the small individuals found at the beginning of the season i.e. in June, are only slightly bigger than those at the end i.e. November, the average weight of group I having dropped to 36 gms. (including young of the year) in August and then increased to 62 gms. in November.

All this confirms that the Bull Frog will ordinarily take all food as is available and its importance and/or usefulness as a pest control may be found to be based on different items in different districts. In the Konkan the food has been consistently similar in the different years, and its main prey are undoubtedly the crabs *Paratelphusa* spp. and others.

5a. Food outside Konkan

The little material that we have been able to obtain in Karwar and Hyderabad shows the food to be of different species from that in the Konkan, e.g. in Karwar the few crabs were *Varuna litterata* while those of the genus *Paratelphusa* were completely absent. Aquatic insects also showed a higher incidence.

In Hyderabad the crab *Paratelphusa* was again the main food, while the insects included a larger proportion of aquatic forms e.g. *Cybister* sp. (26%) water scorpions (26%) and water bugs (15%). But these differences

TABLE 12

STOMACH CONTENTS EXPRESSED AS PERCENTAGES OF TOTAL BODY WEIGHT WITH RESPECT TO SEX, SIZE AND MONTH (1977)

Month & group		Max. recorded		Mean %age		Upto 3%		3-6%		6-9%		over 9%	
Sex		♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
June &	I	7.55	4.66	3.27	3.43	45.45	25.00	36.36	62.52	18.18	12.50	—	—
July	II	3.76	4.30	1.68	2.11	66.66	88.88	33.33	11.11	—	—	—	—
	III	14.20	5.20	4.57	8.64	40.00	0	0	100.00	20	—	40	—
Aug.	I	4.80	7.83	4.40	5.31	0	50.00	0	50.00	100	0	—	—
	II	27.20	13.80	5.75	4.27	28.57	55.55	42.85	11.11	21.42	22.20	—	—
	III	10.62	11.00	4.67	4.43	27.27	30.76	45.45	38.46	18.18	19.23	9.09	11.53
Sept.	I	21.00	23.52	6.97	6.31	18.57	18.29	28.57	36.58	24.28	23.17	28.58	21.95
	II	14.89	8.95	5.51	4.63	7.69	11.11	61.53	77.77	23.07	11.11	7.69	—
	III	7.53	10.60	5.80	5.29	16.66	—	33.33	71.58	50.00	14.28	—	14.28
Oct.	I	17.40	24.00	6.79	6.75	18.46	15.49	30.76	30.98	30.76	32.39	20.00	21.12
	II	14.85	9.61	5.10	4.49	29.16	12.50	45.83	62.50	16.66	20.83	8.33	4.16
	III	8.09	8.25	4.08	3.92	50.00	50.00	16.66	16.66	33.33	33.33	—	—
Nov.	I	12.86	11.90	4.73	6.02	34.78	24.00	39.13	28.00	17.39	12.00	8.69	36.00
	II	4.94	5.32	2.20	2.79	85.42	58.41	14.25	41.66	—	—	—	—
	III	5.40	6.85	3.80	3.08	57.14	44.44	42.85	33.33	—	11.11	—	—
Total	I	21.00	24.00	5.23	5.56	22.20	18.60	30.99	34.57	26.31	24.36	20.46	22.34
	II	27.20	13.80	4.05	3.66	39.43	41.97	40.84	38.27	19.08	14.81	5.63	4.93
	III	14.20	11.00	4.58	5.07	34.78	29.41	34.78	43.13	21.73	17.64	8.69	9.80

TABLE 13

COMPUTERISED PERCENTAGES OF VARIOUS FOOD ITEMS IN FROGS OF DIFFERENT SIZES IN DIFFERENT MONTHS

Month & Group		Average weight of frog	Crab % of body weight	Insect % of body weight	Insect larvae % of body weight	Other matter % of body weight
June & July	I	78 gms.	—	1.98	—	—
	II	103	1.1	4.81	—	8.44
	III	236	—	0.36	—	—
Aug.	I	80	—	—	—	—
	II	173	1.98	0.1	5.87	0.94
	III	233	3.65	5.24	—	1.20
Sept.	I	53	4.86	4.84	5.38	5.82
	II	150	5.15	1.27	6.46	4.94
	III	375	5.09	3.44	5.97	6.74
Oct.	I	44	5.54	3.22	3.87	2.59
	II	142	6.56	3.82	5.36	3.71
	III	298	6.40	2.28	—	—
Nov.	I	70	13.08	4.47	4.42	—
	II	157	5.97	5.15	7.92	6.22
	III	278	6.15	5.5	14.86	6.25
Total	I		8.51	3.40	4.10	4.03
	II		6.49	3.28	6.46	4.20
	III		4.68	3.36	8.71	5.92
Weight of different categories of food		Gr. I	99.24	130.24	76.2	39.17
		Gr. II	3841.52	265.77	203.9	292.68
		Gr. III	5223.91	130.12	147.88	640.84
Total weight and relative percentage		11091.47 100%	9164.67 82.63%	526.13 4.74%	427.98 3.86%	972.69 8.77%

were no doubt dependent upon the availability or otherwise of the different species and the general pattern of feeding remains the same.

The collections were made only in March and the food suggested that the frogs had been feeding largely near small ponds. It is quite possible that the overall picture may change if the inquiry was spread over a longer period.

It also indicated that the frog did not aestivate in areas which are now largely irrigated for rice, and that the very radical trait (of aestivation) varies from place to place being controlled by rainfall or the amount of suitable biotope available.

6. Notes on Rana hexadactyla

The title for the project under report includes *Rana hexadactyla* but, as already clarified under General Remarks above, this species does not occur in Bombay.

Less information was available about its

TABLE 14

COMPUTERISED PERCENTAGES WEIGHT OF VARIOUS FOOD ITEMS IN FROGS OF DIFFERENT SIZES IN DIFFERENT MONTHS.

Month & group		Average weight of frog	Crab	Insect	Insect larvae	Earth worm	Other matter
June & July	I	80	7.0	2.45	2.58	—	5.62
	II	152	3.89	1.18	1.94	—	2.38
	III	280	3.47	0.07	—	—	17.30
Aug.	I	36	—	2.57	4.0	—	—
	II	168	4.26	3.54	3.48	—	9.99
	III	327	4.8	—	7.45	—	1.92
Sept.	I	46	7.33	5.28	13.72	8.54	6.60
	II	136	5.71	3.29	4.85	5.32	9.65
	III	267	5.11	1.62	—	—	9.26
Oct.	I	53	7.99	5.02	7.09	8.65	54.43
	II	115	5.79	4.68	4.14	4.83	5.52
	III	327	4.69	0.68	—	—	—
Nov.	I	62	7.28	3.53	5.2	—	8.26
	II	130	2.51	1.95	2.62	—	2.92
	III	339	3.99	1.82	3.37	—	2.58
Total	I		**7.75**	4.84	9.05	8.45	7.26
	II		4.98	3.31	1.27	4.54	9.79
	III		0.88	1.39	5.24	—	2.96
Total weights of different categories of food		Gr. I	469.83	813.35	652.18	467.92	269.9
		Gr. II	609.38	262.98	149.69	82.8	238.97
		Gr. III	1238.01	54.71	58.22	—	83.32
Total weight and relative percentage		5451.26	2317.22	1131.04	860.09	550.72	592.19
		100%	42.51	20.75	15.78	10.10	10.86

food than of *tigrina* and concurrent with our work we were able to persuade Dr. M. I. Andrews of Mar Thoma College, Tiruvalla, Kerala, to undertake a similar inquiry with the assistance of a grant from the Charles McCann Fieldwork Fund administered by BNHS. His results are published in Society's Journal (1979).

During a short visit to Madras and Trivandrum, Joshi and Hosalkar were also able to obtain a few specimens and the food as determined is listed in Table 8 and indicates 8% crabs, 72% insects, 8% insect larvae, 4% each of snails and earthworms, together with miscellaneous items like spiders, centipedes, fish, tadpoles and snakes (*Typhlops* sp.).

This animal is found most often *in* water and the more aquatic habitat showed that a

greater number of aquatic insects had been eaten. But both reports confirm that the constant representations of the trade that this species is herbivorous and therefore of almost no ecological importance as a pest controller, is exposed as baseless.

7. Inquiry among farmers regarding ecological consequences of frog removal

Though every effort was made to study the Bull Frog in its natural habitat, it has already been explained how it was found to be much rarer than anticipated and very difficult to meet in the field, and the bulk of our inquiry into its food has been carried out on specimens obtained at cutting centres. However, the farmer/villager has always been in direct contact with the frog and it was evident from the few personal conversations made with the cultivators that they had very definite views about frog-catching and associated matters. With the approval of the Collectors of Thane and Kulaba, reply-paid postcards were sent to 1650 police patils in different villages in these districts bearing the following questions:

(1) Has the number of frogs reduced in your place over the last five years?
(2) Is there any loss or benefit due to the removal of frogs?
(3) What is the reason for the loss or benefit and how much is the loss or benefit?

588 replies were received and tabulated. 582 stated that there was a considerable depletion in the number of frogs. Some said that it had disappeared from their area while others reported decreases of 50 to 90%.

577 complained of agricultural losses due to their removal, while 361 specifically stated that this was because of the fact that they used to feed on paddy pests i.e. insects., insect larvae and crabs. 158 said that the pests had increased due to the decrease in frogs. 80 referred to the increased menace of crabs.

To this extent our findings are fully substantiated by local opinion. It was also evident that frog catching, which is essentially at night, creates very serious problems regarding trespass into and damage to standing rice.

8. Experimental attempts in the field

In 1978 arrangements were made with the Agricultural Research Station at Karjat managed by the Konkan Krishi Vidyapeeth, Dapoli, whereby three adjoining plots of land of the same size under rice cultivation were selected. One was completely encircled with nylon netting and 40 adult frogs placed therein, another cleared of all frogs and similarly netted and the third left open to natural conditions. The entomologist attached to the farm, was to make periodic examination of the three plots to determine the differences in pest incidence, if any, and to capture and periodically examine the stomachs of frogs found in plots 1 and 3.

The main purpose was to count the incidence of dead hearts (whiteheads) and ascertaining if rice yields in the three plots varied to any extent. Unfortunately, the Konkan Krishi Vidyapeeth failed to supply us with the information which we had expected to receive. A report was published by them with no acknowledgement to us and the data included may be treated with caution.

9. Conservation and Export Regulations

In response to the first protests against the indiscriminate collection and export of frog legs, this item was first placed under Open General Licence No. 3 which was a mere formality to keep an eye on quantities exported. Later the export of animals (1) captured between 15th June and 15th August, and (2)

small ones showing a count of more than 80 pairs of legs per kilogram, was completely prohibited. But this did not lessen the trade for there was no administrative machinery to determine when the material exported after 15th August was collected and processed, while there was apparently no market for the smaller legs. Attention was drawn to this anomaly, but to no effect.

All frogs of the genus *Rana* have now been brought on the list of animals protected under the Wildlife (Protection) Act 1972 and the packers have to obtain licences and collect and process the legs according to certain terms and conditions. This year (1984/85) an undisclosed ceiling has been placed on the quantity to be exported and it will hopefully be appreciably less than for the previous year.*

10. Findings and conclusions

Much of the information noted above has been recorded piece-meal by earlier workers over many years, but this is the first attempt to re-examine it critically and to put it all together. The following findings differ from what has been accepted or implied:

(a) Maturity is attained at the end of the first season i.e. by about December, though both sexes continue to grow in size for several years.

(b) Frog legs after skinning, cleaning, trimming and processing amount to about 1/3rd of the weight of the live frog.

(c) The breeding season covers a short period at the break of the rains, and there is no evidence of its occurring more than once. Around Bombay, this may commence as early as 25th May and finish by 15th June, rendering ineffective, the protection in the breeding season, attempted under the export regulations.

(d) 90% of the food has been ascertained to consist of crabs, insects and insect larvae. Single crabs are taken for their bulk, but small insects and their larvae must be numerous and in concentrations to permit their being taken in sufficient numbers. The frog therefore takes the role of controller whenever a food item shows an increase in numbers.

(e) It has also been discovered that in addition to *Rana tigrina* and *R. hexadactyla,* large examples of *R. crassa* and *R. cyanophlyctis* are also captured and packed for export. No information is available if this is acceptable to the buyer or if it makes any difference at all. The ecology of these species remains to be studied and the period of protection covered either by the Export Policy or the rules under the Wildlife (Protection) Act 1972 must be suitably arranged for different parts of the country.

The total data now available would warrant the following observations and conclusions.

Ecological

As is evident from the export figures, detailed in Table 1 (p. 349), exports of frog-legs have been rising over the last few years and the business is large enough to have tempted parties like Greaves International, Britannia Seafoods, Tata Oil Mills, and Indian Tobacco to enter it. The total quantity exported in 1977 was about 3000 (4368 in 1981) tons which is equivalent to 9000 (13104 in 1981) tons of live frogs. The food obtained in their stomachs was as high as 29 say 30% of the total weight of the frog, though the average contents are, for various reasons,

* The export quota of 4000 tons has been reduced to 2500.

much lower viz. 7%. Accepting a not unreasonable daily food figure of 10% of its own weight, the removal of 9000 tons of frogs results in the survival or non-destruction of 900 tons of frog food every day, which during the four months June to September adds upto 1,08,000 tons of frog food i.e. 1,00,000 tons (approx. 90%) of crop pests. This is per season of 120 days and reference has already been made to places where living conditions for the frog may be retained for longer periods, as also to the fact that each frog now having attained maturity may live for two or more additional seasons. Considering the obvious depletion which has already taken place in their numbers in the field, their total number can increase several fold, resulting in a proportionate increase in the quantity of agricultural pests eaten by them.

Table 15 indicates the break-up of the food in terms of agricultural pests left undestroyed in the different years in accordance with Table 1. These figures are based on the actual consumption of food by frogs which are killed every year. For every additional year that the animal would have lived, each figure will have to be increased i.e. doubled for two years, tripled for three years, *et. seq.*, until the total frog population has reached the original level which was presumably ecologically stable. A suspension of frog catching may safely be estimated to result in the destruction of at least twice the quantity of pests determined above, i.e. 200,000 tons of crop pests per annum.

There is statistical evidence to the effect that the frogs will ordinarily only eat such items as are available in plenty, for the same item appears consistently in the diet of each individual. Does this not show the frog as a natural controller of any insect or other possible pest which threatens to increase in numbers and appreciable numbers of which are found together ?

The food may vary from place to place but

Table 15

Estimated weights of undestroyed pests (in tonnes) in different years 1963-78

Year	Wt. of frogs killed in tons as per Table 1	Total amount of frog food remaining undestroyed	Crabs	Insects	Insect larvae	Other items
1963	1542.00	18141.12	11755.44	2576.04	1981.01	2757.45
1964	996.00	117176.40	75930.30	16639.05	12795.66	17810.81
1965	1329.00	15635.28	1014.13	2220.21	1707.37	2376.56
1966	1671.00	19658.76	12738.87	2791.54	2146.74	2988.13
1967	2358.00	27741.12	17976.24	3939.24	3029.33	4216.65
1968	1275.93	15010.92	9727.10	2131.55	1639.19	2281.66
1969	2563.11	30154.32	1953.92	4281.91	3292.85	4583.45
1970	7634.61	89818.92	5820.66	12754.29	9808.22	13652.47
1971	4353.42	51216.72	33188.43	7272.77	5592.86	7784.94
1972	5470.45	64358.28	41704.16	9138.87	7027.92	9782.45
1973	8092.80	95209.44	61695.71	13519.74	10396.87	14471.83
1974	4361.90	51316.44	33253.05	7286.93	5603.75	7800.10
1975	3952.45	46499.52	30131.64	6602.93	5077.74	7067.91
1976	9509.65	111878.28	72497.12	15886.71	12217.10	17005.50
1977	8502.61	100030.80	64819.96	14204.37	10923.36	15204.68
1978	10710.00	126000.00	81648.00	17892.00	13759.20	19152.00

the principle of controlling all these items which are increasing in numbers remains. If the land crab today forms the bulk of its food in the Konkan, something else may take its place in the neighbouring Deccan, but this again will be some form of animal which occurs in numerical concentrations and where the frog continues to serve as a controller.

The biological background and consequences are evident, and one can say without hesitation that the removal of large numbers of frogs from their natural environment upsets the existing balance of nature, and in cultivated areas the process is highly detrimental to crops. The consequences have had to be offset by the introduction of pesticides which in turn have further detrimental side-effects and there can be no doubt that the losses will be found to be double-edged and increase with time. It is now generally accepted that biological controls are within reason the safest and only methods which do not produce any harmful reactions, and the removal of large numbers of frogs from our countryside and the collateral use of pesticides is bound to tell strongly.

The quantity exported shows no decline, but this is not because frog numbers are unaffected, but because with rising prices and better organisation, supplies are obtained from over a greater part of the 1,300,000 square miles which make our country. It is an accepted tenet of wild life conservation that the surest means of exterminating or radically reducing the number of any species of plant or animal is to put a price on it, for no species can naturally continue to reproduce itself as fast as man, assisted by mechanical means, can destroy it.

The effects of pesticides are also already visible. DDT taken through their food of rats, mice and insects affects the reproductive capacity of birds of prey. The smaller raptors like the Kestrel (*Falco tinnunculus*) and the White-eyed Buzzard (*Butaster teesa*) which were quite common a few years ago, have now almost completely disappeared from the Konkan. What is the additional number of rats and mice which survive to eat and damage rice and other edibles of man ?

Many species of raptors have been recorded from the Konkan some resident and some migrant. Their numbers have fallen greatly over the last few years, and the absence of the migrants is evidence that the same conditions exist in northern India, Pakistan and beyond, where they breed. The Egyptian Vulture (*Neophron percnopterus*) and the Longbilled Vulture (*Gyps indicus*) which used to nest on the bare rock cliffs at Mumbra, near Thane, on the pinnacle rock at Karnala, and at other places in the neighbouring ghats have also disappeared and the nesting sites are vacant. We do not know how DDT has reached these large birds, or if they have been affected in some other manner.

Economic

The analysis of the food eaten shows that at least 90% is made up of crabs, insects and insect larvae, all of which are undoubtedly detrimental to agriculture i.e. 200,000 tons of pests which would have been destroyed by the surviving frog population after one year of protection, remain untouched. This is cumulative to an incalculable extent.

3000 tons frog leg exports were last valued at Rs. 7 crores and we find that for every 35 paisas earned in foreign exchange, we have prevented the destruction of 1 kg. of agricultural pests. What is the cost to be incurred for their destruction ?

Attention must be drawn to the fact that a very conservative amount of food per frog has been allowed for and no provision has been made for the areas which receive both the

southwest and northeast monsoons or have three crops of rice arranged by irrigation. In such areas the period of activity will be much more than 120 days per annum.

The value of pesticides used in India every year is said to be rupees 200 crores and it is anybody's guess as to how much of this is needed to kill the pests which have escaped the frogs.

The frog is not ordinarily eaten in India and its removal does not lessen any food normally available to the villager. The very emphatic opinion expressed by the villagers to the effect that the removal of the frog is harmful to agriculture is unprejudiced and must command respect.

The crab is a great pest in rice-growing areas. Apart from eating and destroying fresh seedlings, their burrows in the bunds act as drain pipes removing the water essential to rice, and requiring additional labour for repeated repairs.

Collecting the frogs does provide labour for some Kathoris, and other tribals, but this activity coincides with that of rice planting and harvesting and much of this work is done at night. The real profits are made by the middle-man i.e. the processors and the exporters. See concluding paragraph under Field Notes (p. 352).

Educational

The bull frog was the standard subject for dissection and experimental purposes in Zoological/Medical colleges over most of India, the earlier text books being based on them. The difficulty of obtaining specimens has interrupted the practical side of this teaching, which is now compulsorily restricted to theory.

Humanitarian

An inordinate amount of cruelty is attached to this business. The frog is caught alive and several hundred are dumped into a gunny bag which is banged on the ground to permit the contents to settle and then sewn up.

Many such bags are then piled into trucks and driven hundreds of miles to the cutting centres, reaching them several days after capture. We have been informed of consignments in which 90% of the frogs were found dead upon arrival.

At the cutting centres, they are extracted from the bag one by one, gripped by the hind legs, placed under a chopper, and cut into two parts, the front and rear halves both being left to die separately — the front half of the frog resting on its bleeding belly, propped up by its fore feet and staring helplessly at the world around it, is a ghastly sight. Protests against these barbarous methods have appeared in foreign journals and magazines concerned with conservation and the avoidance of cruelty to animals. The Society for the Prevention of Cruelty to Animals in Bombay has failed to take sufficient action, for the whole process is linked with and inseparable from the export of frog legs which is permitted by Government.

Prior to this cutting, the animal is momentarily dipped into a solution of salt and chlorine which is said to be anaesthetic. This is not so, for the solution is only used as a ward against Salmonella and other infections and does not lessen the pain in any manner.

I have been unable to obtain evidence of frogs of any species being bred in captivity, either in India or anywhere else on a commercial basis but it is unlikely that any serious

"Front half of the frog resting on its bleeding belly, propped up by its front feet and staring helplessly at the world around it..." (page 374).

Photo: Courtesy — World Society for Protection of Animals.

Discarded portions — still alive and to be dumped into garbage heaps.
Photo: (above): Courtesy — World Society for Protection of Animals.
(below): Courtesy — Beauty Without Cruelty.

effort will be undertaken in this direction so long as sufficient quantities can be caught in the wild, and there is no base cost. Nor am I aware of such business (i.e. catching in the wild) being possible or permitted in any developed country.

With cheaper labour and all the other natural factors being available, it may be possible to breed them in India, though it is difficult to estimate if the price would be workable. In any case, the present removal of an important link in the biological chain sustaining the economy and ecology of our countryside is unwarranted and should be stopped immediately.

Acknowledgements

In concluding this report, I would like to record my indebtedness to the Indian Council of Agricultural Research for giving me the opportunity of undertaking the inquiry suggested by me; the Bombay Natural History Society for having sponsored the project; Messrs Sawant Fisheries Pvt. Ltd., Exporters of Frog Legs in Bombay, and Messrs Jadhav and Dhabia, Frog Suppliers at Karjat, for having given us access to the material collected by them and enabling us to handle large numbers which would not otherwise have been available; Agricultural Research Station of Konkan Krishi Vidyapeeth at Karjat, for having permitted access to their rice fields; the Zoological Survey of India, Calcutta, for the identification of stomach contents; and Mr. Nazar Futehally of Technical Development Pvt. Ltd., for the computerisation of the data relating to the stomach contents.

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NEW DESCRIPTIONS

TWO NEW SPECIES OF *CHRYSOCHARIS* FORSTER (HYMENOPTERA: EULOPHIDAE) FROM HIGH ALTITUDE OF INDIA[1]

M. A. KHAN[2]

(With fourteen text-figures)

Chrysocharis indicus sp. nov. and *Chrysocharis funicularis* sp. nov. reared from pupae of *Phytomyza* sp. (Diptera: Agromyzidae) from high altitude of India are described and illustrated. Key to some Asiatic species of the genus *Chrysocharis* based on females is proposed.

Genus *Chrysocharis* Forster 1856, *Hym. Studien, Heft* 2: 79, 83.

Type species: *Chrysocharis femoralis* Forster.

Chrysocharis Forster is an easily recognised genus of the subfamily Entedontinae (Eulophidae). It is characterised by the parapsidal furrows usually partly indicated, body weakly sclerotized, pronotum without margined collar, marginal vein moderately arched, post marginal vein generally much longer than stigmal vein, antennae usually with 3 annelli, sometimes with 2.

Recently Yoshimoto (1973a, b) has revised the genus in great detail. The generic characters proposed by him apply well to the species under study. In addition, some new characters have been suggested which might help in the separation of this genus from closely allied ones. The characters are: first valvifer triangular with articular knobs well prominent, third valvulae short, lanceolate, movably articulated with second valvifer, outer plate of ovipositor with broad apex and a ridge along dorsal margin.

KEY TO SOME ASIATIC SPECIES OF THE GENUS *Chrysocharis* BASED ON FEMALES

1. Flagellum with three funicle segments and two segmented club 2
1. Flagellum with four funicle segments and two segmented club, antennae uniformly dark brown, scape, greatly flattened, two anneli present .... *C. funicularis* sp. nov.
2. Legs (except coxae) pale 3
2. Legs beyond coxae pale except hind femora & pulvillus brown 4
3. Petiole mainly strongly reticulate, coxae uniformly brown 5
3. Petiole not likewise, coxae pale except bases slightly infuscated, ocelli arranged in obtuse angle triangle, head with very poor reticulations, pronotum with anterior margin deeply concave in the middle, posterior margin almost straight with six long setae; petiole long, almost one third length of abdomen...... *C. indicus* sp. nov.
4. Head broader than thorax, antennae dark brown to fuscous except scape pale to light brown along ventral margin and fuscous along dorsal margin with three large ring segments, forewing hyaline, scape more than three times longer than wide, pedicel longer than first funicle segment, less than twice longer than wide .... *C. pentheus* (Walker)

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4. Head nearly as wide as thorax, antennae dark brown except scape with basal half pale, one minute, narrow ring segment, forewing hyaline except for a conspicuous and short brown infumation from the stigma backwards across the width of a short distance and gradually disappearing before the middle of wing, scape slender, almost seven times as long as wide, first funicle segment about three-fourths the pedicel .... *C. horticola* Mani
5. Scutellum purplish, rest of the thorax greenish, petiole transverse, roughly reticulate .... *C. phryne* (Walker)
5. Scutellum coloured green to blue or golden like the rest of the thorax, occiput margined throughout, propodaeum-alutaceous, shiny .... *C. polyzo* (Walker)

Chrysocharis indicus sp. nov. (Figs. 1-9)

FEMALE:

Head: (Fig. 1): Dark brown with greenish reflections, wider than long in facial view (0.54: 0.35), width of frons between eyes more than half the head width, frontovertex wide, ocelli arranged in obtuse angle triangle; malar space slightly shorter than transverse diameter of eye (0.1:0.12); antennae inserted just above the lower eye margins; distance between two antennal sockets almost their distance between eye rim (0.07-0.06); mandibles (Fig. 2) bidentate with sharp apices, maxillary & labial palp each one segmented.

Antennae (Fig. 3): Uniformly light brown except scape yellowish with slight infuscation on apex; scape cylindrical, slightly more than six times longer than wide (0.19:0.3); pedicel less than twice as long as wide (0.07:0.04), three anneli present, 3rd anneli almost quadrate (0.03: 0.25), funicle three segmented, Ist funicle segment three times as long as wide (0.09:0.03), funicle segments 2nd and 3rd decreasing in length distad, club two segmented, slightly more than three times longer than wide, shorter than preceeding two funicle segments combined, Ist funicle to last club segment with 3, 4, 5, 7, 4 & 4 sensoria respectively.

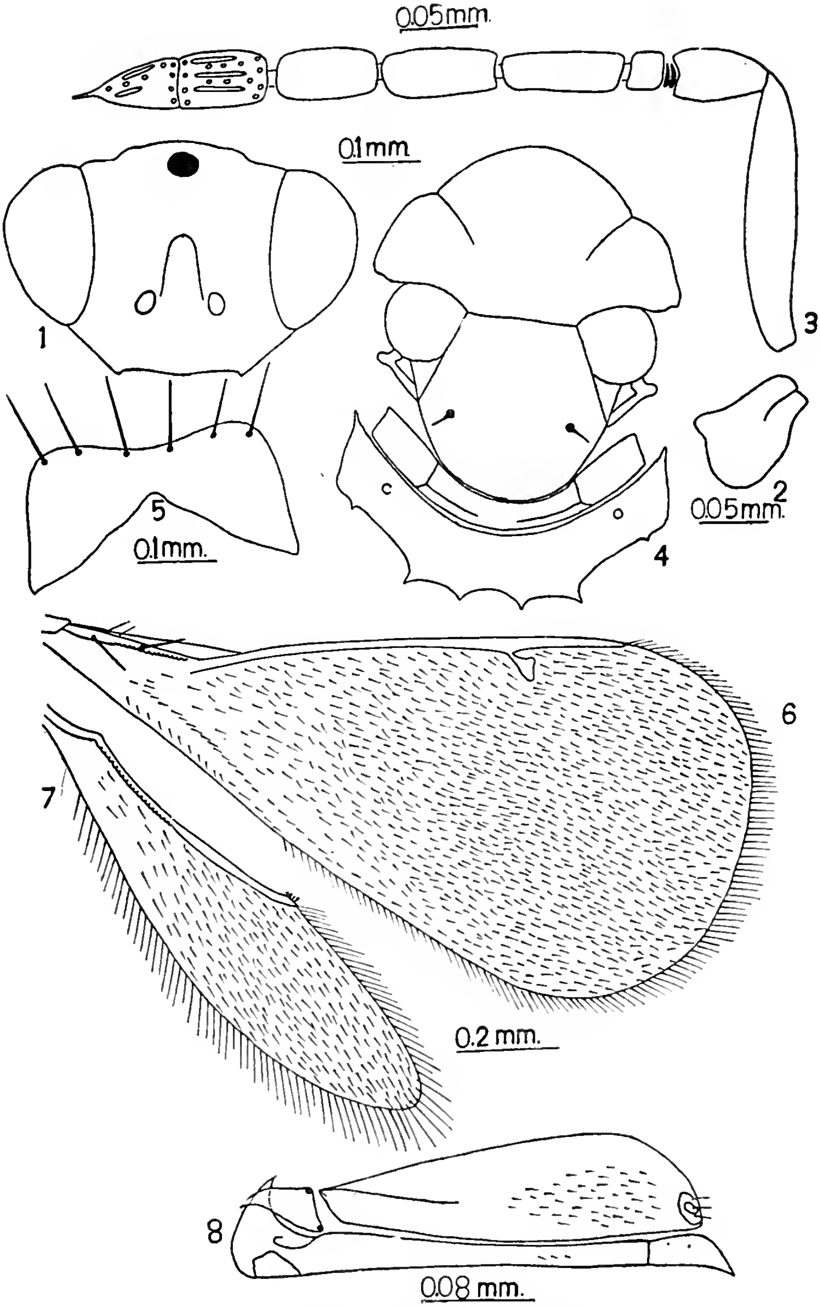
Thorax (Fig. 4): Dark brown with shining bluish green reflections on the dorsum with fine hexagonal reticulate sculpture; pronotum (Fig. 5) with anterior margin deeply concave in the middle, posterior margin almost straight with six long setae; scutum slightly more than twice wider than long (0.42:0.2), axilla widely separated from each other; scutellum wider than long (0.37:0.23), shorter than scutum; sparsely setose; surface of propodaeum smooth; mesal length two fifth as great as length of scutellum, both median and lateral carinae present, propodael spiracle separated from anterior margin by a space equal to diameter of a spiracle; callus sparsely setose with fine, thin setae.

Fore Wings: (Fig. 6): Hyaline, two times longer than wide; costal cell short with three setae, basal cell almost asetose with only a few basal setae on ventral surface; marginal vein very long (0.55); post marginal vein (0.24) more than three times the length of stigmal vein (0.07); marginal fringe very short.

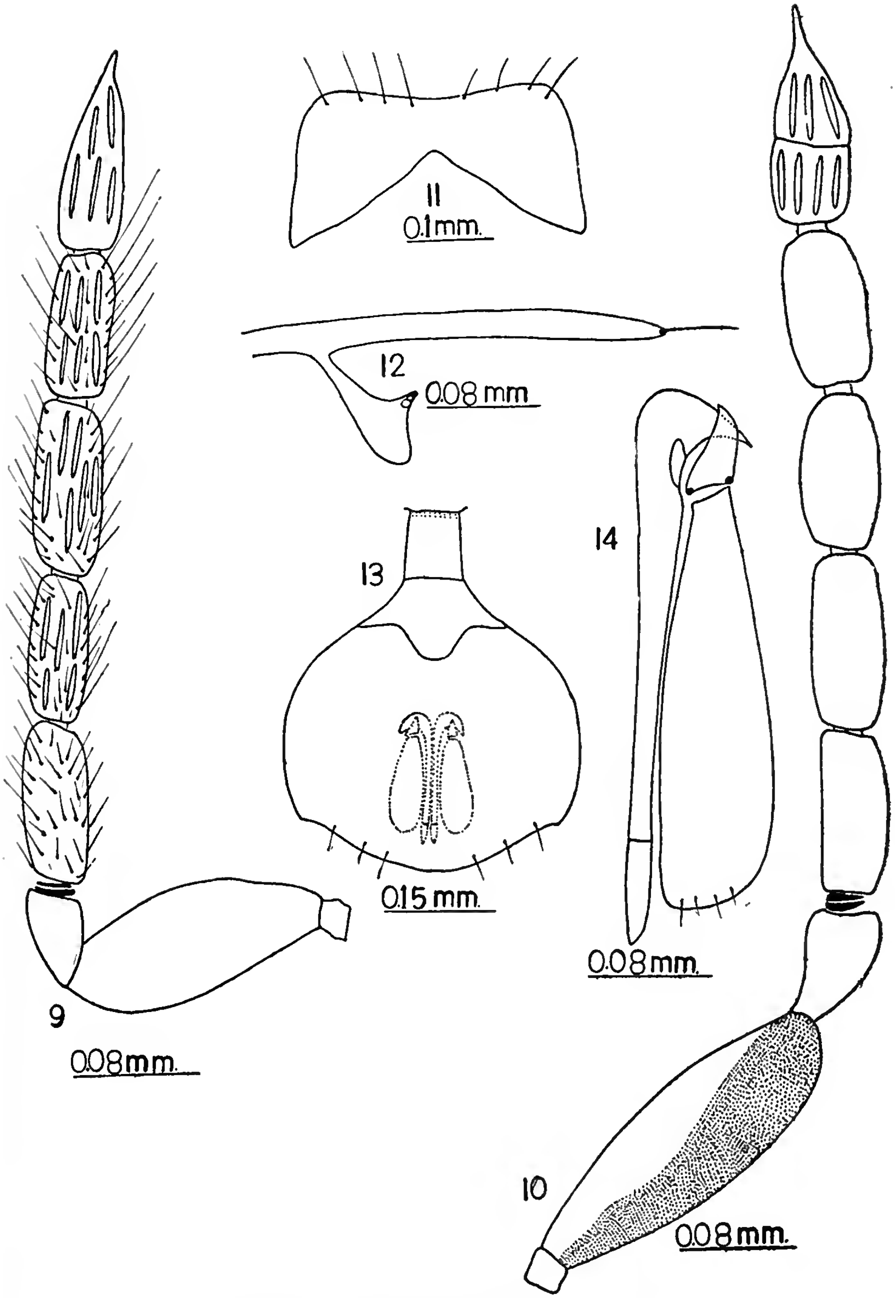
Hind Wing (Fig. 7): Hyaline, slightly more than four times longer than wide; apex of marginal vein with three curved hook-lets.

Legs: Pale yellow except bases of coxae slightly infuscated.

Abdomen: Dark brown with shining bluish green reflections, longer than thorax excluding length of petiole, petiole long, one third length of abdomen (0.16:0.5); ovipositor concealed; first valvifer triangular with articular knobs prominent (Fig. 8); second valvifer of uniform width; third valvulae short, lanceolate, movably articulated with second valvifer; outer plates of ovipositor with broad apex (Fig. 8).
Length of Female: 1.52 mm.



Figs. 1-9. *Chrysocharis indicus* sp. nov.
1. Head, frontal aspect, ♀; 2. Mandible, ♀; 3. Antenna, ♀; 4. Thorax, dorsal aspect, ♀; 5. Pronotum, ♀; 6. Forewing, ♀; 7. Hindwing, ♀; 8. Genitalia, ♀; 9. Antenna, ♂ (see p. 379).



Figs. 10-14. *Chrysocharis funicularis* sp. nov. ♀
10. Antenna; 11. Pronotum; 12. Part of forewing venation; 13. Abdomen, dorsal aspect; 14. Genitalia.

MALE: Resembles the female except in the following characters:

Antennae (Fig. 9): Uniformly brownish, scape whitish; scape greately flattened, almost two and a half times longer than wide (0.17: 0.07); pedicel one and a half times longer than wide (0.06:0.04), an anellus present, first funicle segment less than three times longer than wide (0.1:0.04), longer than preceding second funicle segment (0.09), third funicle segment (0.15) a trifle longer than first, fourth segment (0.09) equal to second segment in length; club unsegmented, less than four times longer than wide (0.14:0.04), longer than preceding segment, mandible bidentate with blunt teeth.

Length of male: 1.42 mm.

Holotype: ♀, ♂ India, U.P., Ranikhet (6500′) ex *Phytomyza* sp. (Diptera: Agromyzidae) on Thalictrum 3.11.1977. Hym. Eulo. Nr. 1017 (M. A. Khan).

Paratype: 80 ♀♀, 20 ♂♂ same data as holotype. Hym. Eulo. Nr. 1018 (M. A. Khan). Material will be deposited in the Zoological Survey of India, Calcutta.

Chrysocharis funicularis sp. nov. (Figs. 10-14)

FEMALE: Differs from *C. indicus* sp. nov. as follows :-

Antennae (Fig. 10): Uniformly dark brown except a yellowish strip at ventral side of the scape, scape greatly flattened, a trifle three times longer than wide (0.22:0.07), pedicel almost one and a half times longer than wide (0.08:0.05), two anneli present, first funicle segment more than twice longer than wide (0.1:0.04), second funicle segment a trifle longer than first, third and fourth funicle segments subequal (0.095:0.045), club two segmented, less than three times longer than wide (0.14:0.05), longer than preceding segment.

Fore Wings: More than twice longer than wide, post marginal vein more than twice the length of stigmal vein (Fig. 12).

Legs: Uniformly light brown except the hind coxae dark brown.

Abdomen (Fig. 13): Light brown except petiole and basal end yellowish shorter than thorax excluding length of petiole, petiole short, less than one fifth length of abdomen; apex of abdomen deeply rounded; genitalia as shown in Fig. 14.

Length of female: 1-1.5 mm.

MALE: Not known.

Holotype: ♀, India, U.P., Ranikhet (6500′) ex *Phytomyza* sp. (Diptera: Agromyzidae) on Thalictrum 4.11.1977 Hym. Eulo. Nr. 1019 (M. A. Khan).

Paratype: 10 ♀♀ same data as holotype. Hym. Eulo. Nr. 1020 (M. A. Khan). Material will be deposited in the Zoological Survey of India, Calcutta.

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FIVE NEW SPECIES OF *SIOBLA* CAMERON (HYMENOPTERA: TENTHREDINIDAE) FROM INDIA WITH A KEY TO THE INDIAN SPECIES[1]

Malkiat S. Saini, Devinder Singh,
Major Singh and Tarlok Singh[2]

(*With nine text-figures*)

Five new species, *Siobla infuscata, S. kalatopi, S. malaisei, S. bengalensis* and *S. darjeelingia,* and one subspecies, *S. kalatopi ahlaensis,* are described from India. A key to the known Indian species is provided.

Introduction

Five new species and one new subspecies of *Siobla* from northern and northeastern India are described below. So far, only one species, *S. turneri* Malaise 1934 and a subspecies *S. mooreana punctata* Cameron 1899, have been reported from this region. With the first record of *S. mooreana* Cameron 1877, from India, the number of known species and subspecies from this region is seven and two, respectively. The concerned literature reveals that after Malaise (1934) no additions have been made to the list of Indian *Siobla.* Holotypes will be deposited in the Zoological Survey of India, Calcutta.

This is the second report in the series of papers dealing with new records of Symphyta from India.

Siobla infuscata sp. nov.

Female: Length 13.8 mm. Body metallic blue except antennal segments 6-9 which are black and following brownish black; labrum, mouthparts and tarsi of four front legs. Forewings strongly infuscated all over, hindwings sub-infumated, stigma and veins brown to black.

Clypeus truncate, labrum convex with roundly pointed deflexed anterior margin; malar space almost 2x diameter of an ocellus; inner margins of eyes emarginate and slightly converging downwards; lower interocular distance 1.25x eye length; ratio of distance from posterior ocellus to eye, to distance between posterior ocelli, to distance from posterior ocellus to hind margin of head, 1.0:0.75:1.0. Antenna longer than head and thorax combined; 1st and 2nd antennal segments each longer than broad; length of 3rd and 4th in ratio 3:1.75; 4-9 gradually decreasing in length. Frontal area raised to level of eyes; supra-antennal tubercles raised and confluent with frontal ridges; circum and interocellar furrows sharp; lateral furrows deep and postocellar area slightly broader than long. Head strongly carinate behind eyes. Scutellum pyramidally raised.

Head densely punctured, size and shape of punctures variable. Pronotum densely punctured with its anterior border impunctate. Mesonotum distinctly punctured, but punctures smaller than those on head, irregular area in middle of each mesonotal lateral lobe with minute punctures; scutellum with very large and deep punctures; appendage impunctate; postscutellum likewise punctured. Mesopleuron rugously punctured; mesosternum densely and minutely punctured. Metapleuron

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and metasternum distinctly punctured. Stripe along the posterior aspect of each pleural suture impunctate. All abdominal segments minutely cross-striated and irregularly punctured. Body covered with silvery pubescence. Female lancet (Fig. 5).

MALE: Unknown.

Material examined: Holotype ♀, 5.6.83, collected from Mandal area, U.P., India 2195 m.

The name of this species is derived from the distinct infuscation of the forewings.

This specimen is included in the genus *Siobla* since it runs in Malaise's (1945) key to that genus. However, in contrast to all other known species of *Siobla*, it has only one closed middle cell instead of two in the hindwing. In all other respects it resembles *Siobla*.

Siobla kalatopi sp. nov.

FEMALE: Length, 12.1 mm. Body reddish yellow, labrum yellowish, dark brown to black are: narrow stripe encircling each ocellus, tip of mandible, posteroventral borders of pronotum, entire propleuron, large spot on each mesonotal middle lobe, irregular spots lateral to scutellum, dorsal borders of mesopleuron, entire mesosternum, most of metapleuron except a large irregular spot in its middle, entire metasternum, and spot in middle of first abdominal tergum. 5th and 6th sterna with a brownish tinge. Legs reddish yellow, dark brown to black are: spots on lateral sides of forecoxae and proximal 3/5th of mid and hind coxae. Wings yellowish hyaline, front ones sharply infuscated from apex to proximal end of stigma, hind ones infumated toward tips; intercosta reddish yellow; stigma and veins dark brown.

Clypeus truncate; labrum convex with deflexed and roundly pointed anterior margin; malar space 2x diameter of an ocellus; inner margins of eyes slightly emarginate and converging downwards; lower interocular distance about 1.3x eye length; ratio of distance from posterior ocellus to eye, to distance between posterior ocelli, to the distance between posterior ocellus and hind margin of head, 1.0:0.4:0.6. Antenna as long as head, thorax and first abdominal segment combined, Ist and 2nd antennal segments longer than broad, length of 3rd and 4th in ratio 5:3; 4-9 gradually decreasing in length. Frontal area raised to level of eyes, supraclypeal pits distinct, supra-antennal tubercles raised and confluent with frontal ridges; circum and interocellar furrows deep; postocellar furrows sharp and diverging posteriorly, postocellar area broader than long. Head carinated and narrowing behind eyes.

Head densely and uniformly punctured. Punctures on pronotum larger than those on head; propleuron shining and minutely punctured. Mesonotum uniformly and finely punctured; scutellum with few isolated punctures on its anterior slope and large confluent punctures on posterior slope; appendage impunctate; postscutellum densely punctured. Punctures on mesopleuron larger than those on mesonotum; mesosternum shining but with distinct punctures; metapleuron distinctly punctured. Punctures missing in narrow stripes posterior to pleural sutures; metasternum uniformly punctured. Abdomen shining, segments 4-8 with minute punctures on their lateral sides. Body covered with golden pubescence. Female lancet (Fig. 2).

MALE: Unknown.

Material examined: Holotype ♀, 7.8.82, collected from Kalatop area (H.P.), India — 2500 m.

Paratypes: 4 ♀♀, with same data as the holotype.

The name of the species is from the type locality.

Siobla kalatopi ahlaensis subsp. nov.

Resembles *Siobla kalatopi* but differs by its dark brown colour, which covers following: supra-antennal and interocellar areas, pronotum except posterodorsal yellow spots, mesopleuron except two large yellow spots, metapleuron, spot in front of scutellum, first abdominal segment except lateral yellow spots, anterior border of 2nd segment, 5th and 6th segments entirely, distal border of 4th and proximal border of 7th. Infuscation of forewings reaching the base. Female lancet (Fig. 4).

MALE: Unknown.

Material examined: Holotype ♀, 4.7.83, collected from Kalatop area (H.P.), India-2500 m.

Paratypes: 2 ♀♀, with same data as the holotype.

The name of the subspecies is from the type locality.

Siobla malaisei sp. nov.

MALE: Length, 11.1 mm. General body colour black, brown are: tips of mandibles, mouthparts and four front legs except coxae, trochanters and posterolateral side of femora which are black. Wings hyaline, veins and stigma brown to black.

Clypeus truncate, labrum convex with deflexed and roundly pointed anterior margin; malar space equal to diameter of an ocellus; inner margins of eyes slightly emarginate and strongly converging downwards, lower interocular distance almost equal to eye length; ratio of distance from posterior ocellus to eye, to distance between posterior ocelli, to distance from posterior ocellus to hind margin of head, 1.5:0.7:1.0. Antenna as long as head, thorax, and first two abdominal segments combined, Ist and 2nd antennal segments longer than broad; length of 3rd and 4th in ratio 4:3; 4-9 gradually decreasing in length. Frontal area raised to level of eyes; supraclypeal pits distinct; middle fovea raised; supra-antennal tubercles raised and confluent with frontal ridges; inter and circumocellar furrows distinct; postocellar furrows sharp and outwardly curved; lateral area broader than long. Head carinated and converging behind eyes.

Head densely punctured; punctures more dense in frontal region. Pronotum with distinct punctures that are less dense near anterior border. Propleuron shining and impunctate. Mesonotum uniformly punctured, punctures smaller than those of head. Scutellum with few scattered punctures on its anterior slope and densely punctured on posterior one; appendage impunctate. Mesopleuron strongly punctured; punctures missing from a stripe posterior to pleural sutures. Mesosternum densely punctured, punctures similar to those on mesonotum. Postscutellum densely punctured; metapleuron with uniform small punctures; metapostnotum impunctate. Abdominal terga 1-3 punctured only on their lateral aspects, remaining terga minutely punctured, all over. Body covered with thick silvery pubescence. Male genitalia (Figs. 6 and 8).

FEMALE: Unknown.

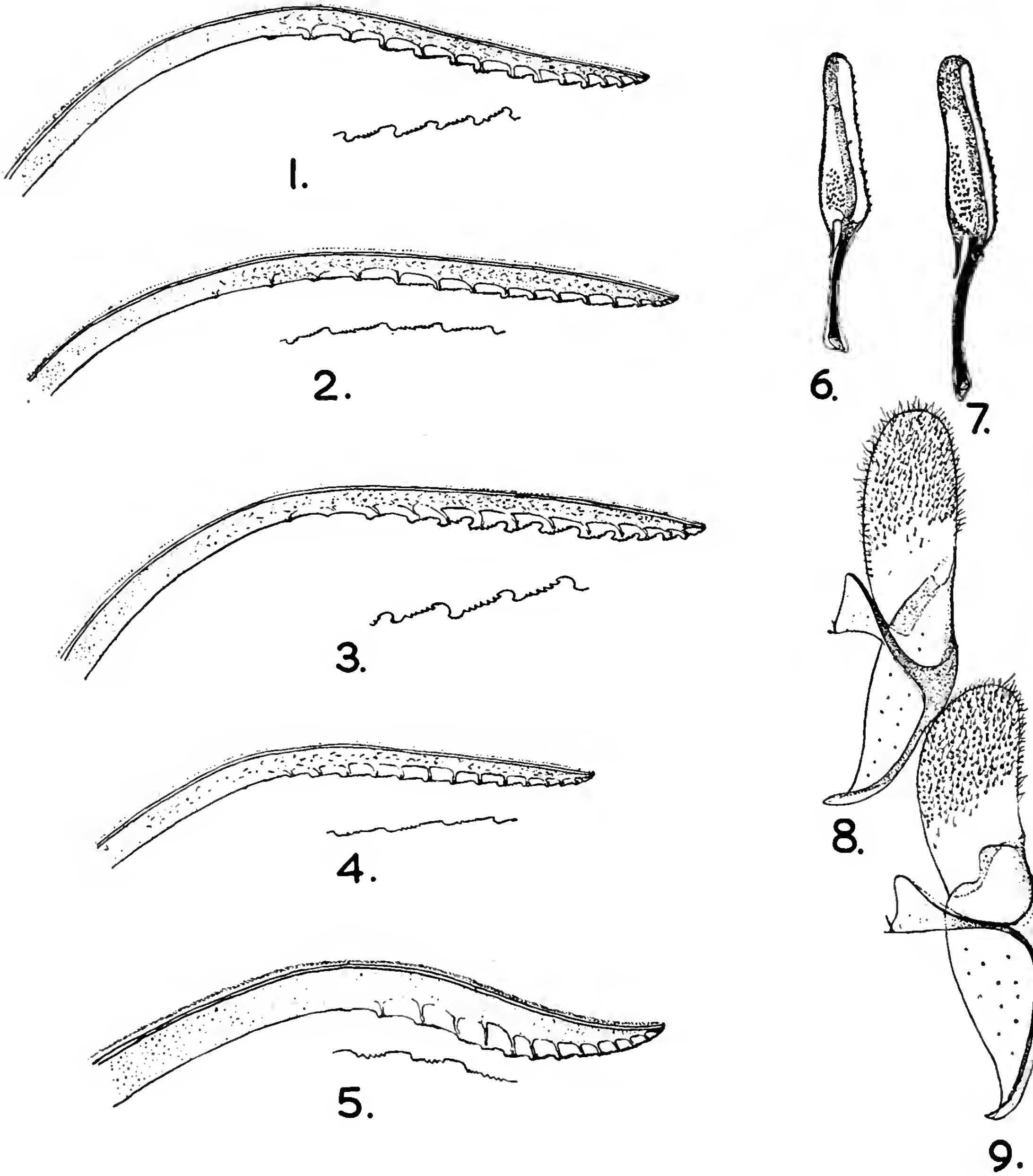
Material examined: Holotype ♂, 5.5.1983, collected from Darjeeling area (W.B.), India — 2286 m.

Paratypes: 70 ♂♂, with same data as the holotype.

This species is named after the late Dr. R. Malaise, known the world over for his work in the field of sawfly taxonomy.

Siobla bengalensis sp. nov.

FEMALE: Length, 13.5 mm. Antenna black with segments 6-9 entirely and distal tip of



Figs. 1-9. 1. Female lancet of *Siobla darjeelingia* sp. nov.; 2. Female lancet of *Siobla kalatopi* sp. nov.; 3. Female lancet of *Siobla bengalensis* sp. nov.; 4. Female lancet of *Siobla kalatopi ahlaensis* subsp. nov.; 5. Female lancet of *Siobla infuscata* sp. nov.; 6. Penis valve of *Siobla malaisei* sp. nov.; 7. Penis valve of *Siobla mooreana* Cameron; 8. Male harpe and parapenis of *Siobla malaisei* sp. nov.; 9. Male harpe and parapenis of *Siobla mooreana*.

5th yellowsh white. Head black; tip of mandible reddish brown, mouthparts brownish and distal 2/3 of clypeus yellowish white. Thorax black, yellowish white are: posterior and posterodorsal borders of pronotum, scutellum, appendage, and postscutellum. Abdomen black, yellowish white are; triangular spot in middle of first tergum, deflexed sides of 2nd, inconspicuous spots on lateral sides of 8th, and the last entirely. Legs yellowish white, blackish are: coxae except their apical tips, four front femora except their proximal and distal ends, hind femora except their proximal ends, and distal 2/5th of hind tibia. Four front tibiae and all tarsi are subinfumated towards their distal ends. Wings hyaline, stigma and veins brown to black.

Clypeus truncate to narrowly rounded; labrum strongly convex with its anterior margin deflexed and roundly pointed; malar space about 1.5x diameter of an ocellus; eyes converging downwards; lower interocular distance 1.3x eye length; ratio of distance from posterior ocellus to eye, to distance between posterior ocelli, to distance from posterior ocellus to hind margin of head, 1.3:0.4:0.9. Antenna as long as head, thorax, and first abdominal segment combined; Ist and 2nd antennal segments longer than broad; length of 3rd and 4th in ratio 8:5 and 4-9 gradually decreasing in length. Frontal area raised to level of eyes; inter and circumocellar furrows distinct; lateral furrows sharp and diverging posteriorly, postocellar area convex and broader than long. Head carinate and converging behind eyes.

Head distinctly punctured; punctures more dense and irregular in frontal region; hind orbits sparsely punctured. Pro and mesonotum densely punctured, punctures smaller than those on head. Scutellum with large punctures on its anterior slope and densely punctured on posterior slope; appendage impunctate; postscutellum with distinct punctures. Propleuron impunctate; mesopleuron with large punctures; mesosternum densely punctured, punctures smaller than those on mesopleuron. Metapleuron and metasternum densely and minutely punctured. A stripe along the posterior side of each pleural suture impunctate. Abdomen minutely punctured, impunctate are: three basal segments entirely and broad spots in middle of segments 4-6. Female lancet (Fig. 3).

MALE: Unknown.

Material examined: Holotype ♀, 4.5.1983, collected from Darjeeling area (W.B.), India-2286 m.

Paratypes: 4 ♀♀, with same data as the holotype.

The name of this species is from the state in which the type locality is situated.

Siobla darjeelingia sp. nov.

FEMALE: Length, 13.6 mm. Antenna black, yellowish to fulvous are: segments 6-9 entirely, tip of 5th and dorsal side of 1st. Head black, fulvous are: clypeus, labrum, basal half of mandible, palpi, triangular spot on middle fovea, irregular spots on lower inner and hind orbits, and most of postocellar area. Thorax black, yellowish to fulvous are: spots near anteroventral margins and posterior and posterodorsal borders of pronotum, basal halves of tegulae, scutellum, appendage, and postscutellum. Abdomen black, fulvous are: 1st and 2nd abdominal terga entirely and large spots on lateral sides of 3rd. Legs fulvous, black are: coxae except their distal tips. Wings hyaline, stigma and veins dark brown to black.

Clypeus truncate with irregular anterior margin; labrum convex with deflexed anterior margin semicircularly rounded; malar space about the length of pedicellus; inner margins of eyes slightly emarginate and converging downwards; lower interocular distance almost

1.5x eye length; ratio of distance from posterior ocellus to eye, to distance between posterior ocelli, to distance from posterior ocellus to hind margin of head, 1.5:0.75:1.0. Antenna slightly longer than head and thorax combined; 1st and 2nd segments each longer than broad; length of 3rd and 4th in the ratio 4:3, 4-9 gradually decreasing in length. Frontal area raised to level of eyes; supra-antennal tubercles raised and confluent with frontal ridges; supra-clypeal pits distinct; inter and circumocellar furrows deep and distinct; lateral furrows sharp, outwardly curved, and postocellar area broader than long. Head carinate and converging behind eyes.

Head densely punctured and area between punctures shining; punctures larger and area sub-shining in frontal region. Pro- and mesonotum uniformly punctured, punctures smaller than those on head. Anterior slope of scutellum with few large and isolated punctures, posterior one densely punctured; appendage impunctate. Propleuron shining with small but distinct punctures. Mesopleuron with very large and confluent punctures; mesosternum with punctures similar to those on mesonotum. Postscutellum distinctly punctured; metapleuron and metasternum minutely punctured. Punctures missing and area shining from stripes posterior to pleural sutures. First three abdominal segments impunctate except lateral sides, all others cross striated and minutely punctured with impunctate areas in middle of segments 4-7. Female lancet (Fig. 1).

MALE: Unknown.

Material examined: Holotype ♀, 9.5.1983, collected from Darjeeling area (W.B.), India 2286 m.

Paratypes: 2 ♀♀ with same data as the holotype.

The name of this species is from the type locality.

KEY TO THE INDIAN SPECIES OF *Siobla* CAMERON

1. — Body without metallic lustre 2
   — Body metallic blue except apical four antennal segments black and following brownish black: labrum, palpi, and tarsi of four front legs....
   Mandal (U.P.) .... *Siobla infuscata* sp. nov.
2. — At least 4 basal segments of antenna black 3
   — Antenna reddish yellow, without black.
   a) Narrow dark brown stripe encircling each ocellus; supra-antennal and interocellar areas of general body colour. Dorsal border of mesopleuron and a spot in the middle of first abdominal segment, brownish black. Apex of front wing infuscated ....
   Kalatop, Dalhousie (H.P.) ....
   ....*Siobla kalatopi* sp. nov.
   b) Entire antennal and supraclypeal area, most of the mesopleuron, first abdominal segment except lateral spots, 5th and 6th abdominal segments, brownish black. Front wings infuscated all over.
   Ahla, Kalatop, Dalhousie (H.P.)...........
   ....*Siobla kalatopi ahlaensis* subsp. nov.
3. — Forewings distinctly infuscated towards apex.
   a) Labrum, clypeus, base of mandibles, apical four antennal segments, pronotal upper and lower angles, scutellum, appendage, postscutellum, middle of broad hind margin of propodeum, entire 2nd tergite, lateral spots on 3rd tergite, four front legs except bases of coxae and a broad stripe along femora, basal 3/5th of all tibiae, and all tarsi, pale.
   Mandal (U.P.) ....*Siobla mooreana* Cameron 1877
   b) Antennae, scutellum and hind legs black, without pale markings. Anterior aspects of front legs sordid brown. ....
   Shillong ....*Siobla mooreana punctata* Malaise 1945.
   — Front wings hyaline or only infumated at base 4
4. — Antenna including general body colour black, brownish are: apex of mandible, mouthparts, labrum, four front legs (except coxae, trochanters and postero-lateral sides of femora)
   Darjeeling (W.B.) .... *Siobla malaisei* sp. nov.

— At least apex of antenna pale............5

5. — Only extreme apex of antenna paler, hind trochanters black. Puncturation on head rather dense; hind tibiae at apex only with a minute black spot or infuscation on inner side....... Shillong ....*Siobla turneri* Malaise 1934

— Four apical antennal joints, hind trochanters, posterior and posterodorsal angles of protergum, and scutellum, pale to fulvous.........6

6. — Coxae except their apical tips, four front femora except their proximal and distal ends, hind femora except their proximal ends, distal 2/5th hind tibiae, and entire abdomen, black. Darjeeling (W.B.) ....*Siobla bengalensis* sp. nov.

— Legs entirely fulvous except basal 4/5th of coxae. First and second abdominal terga entirely and large spots on lateral sides of third fulvous. .... Darjeeling (W.B.) ....*Siobla darjeelingia* sp. nov.

ACKNOWLEDGEMENTS

We thank Dr. D. R. Smith of Systematic laboratory, U.S.A., Washington, D.C. for constructively criticizing and going through the manuscript. Thanks are also due to the ICAR, New Delhi for providing financial assistance.

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ON A NEW CLADOCERAN *LATONA NARENDRAI* SP. NOV. FROM MADHYA PRADESH, INDIA[1]

PRAMOD RANE[2]

(*With three text-figures*)

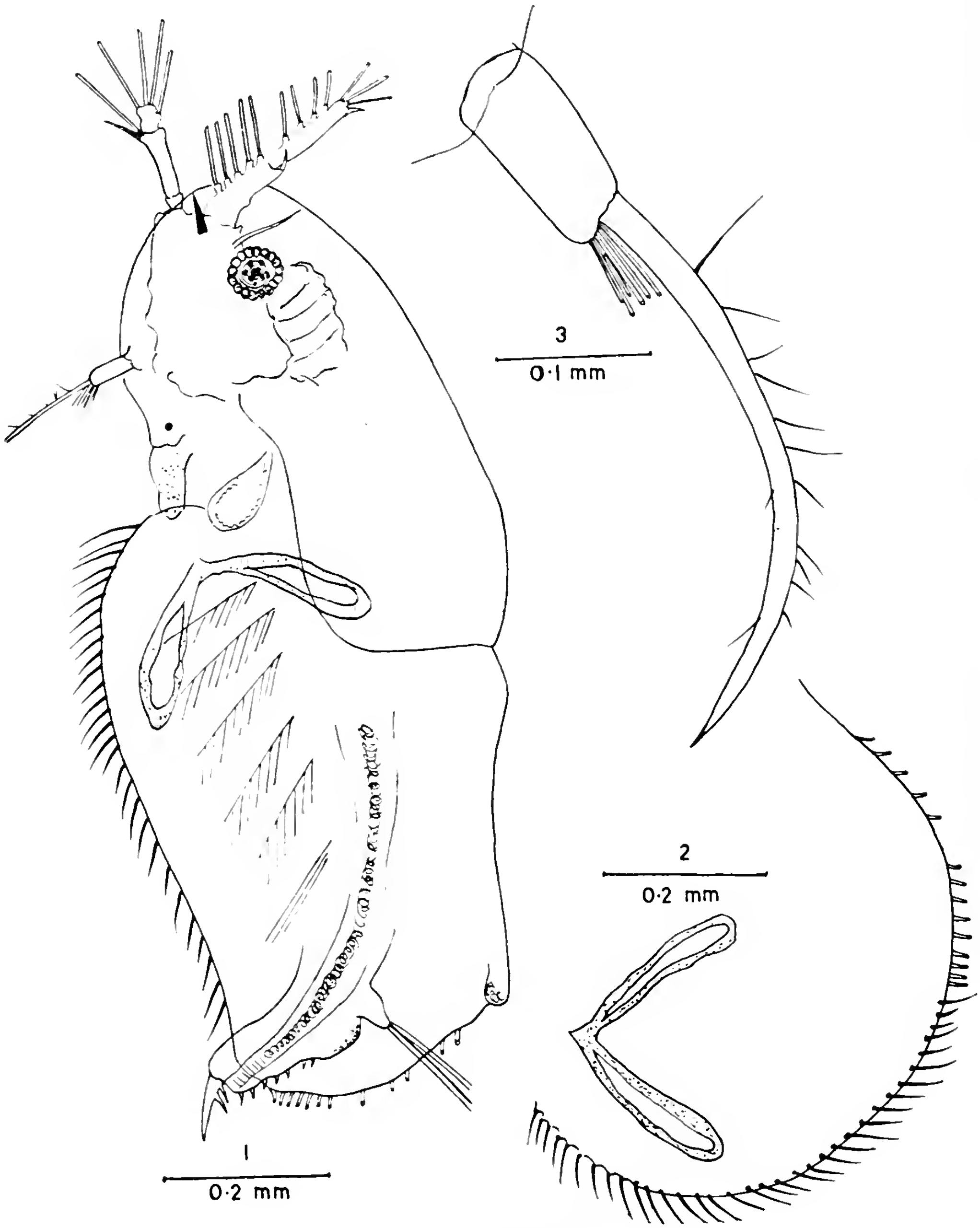
Cladocera of genus *Latona* Straus, 1820 (Family: Sididae) are not so well known from India. Previously only one species *Latona tiwarii* was described from Rajasthan by Biswas (1964). In the present note the genus *Latona* is recorded for the second time from the Indian subcontinent and a new species is described from Mandla district of Madhya Pradesh.

[1] Accepted January 1984.

[2] Zoological Survey of India, Central Regional Station, Jabalpur 482 002, India.

Latona narendrai sp. nov.

FEMALE: Body flattened, nearly quadrangular in shape. Infero-postal and supro-postal angles rounded. Long setae on posterior margin of valves (often lost as shown in fig. 1). Setae also present along the entire ventral margin of valve. Distinct dorsal impression between head and shell. Head very large, rounded, somewhat more than half the total length of body. Eyes placed centrally, with numerous lenses and very large pigmented area. Rostrum absent. Basal joint of antenna large, stout, as in



Figs. 1-3: *Latona narendrai* sp. nov.
1. Holotype female — lateral view; 2. Right valve of female with two-branched shell gland; 3. Right antennule.

other species of the genus, armed with one thorn at the base. Dorsal ramus 2-jointed, basal joint more than twice as long as broad, with 4-5 feathered setae and without lateral antennary expansion. Distal segment of dorsal ramus with 7 setae. Ventral ramus three-jointed, first segment without setae, second with one seta, and third with one lateral and three terminal setae. Hepatic caeca, two-branched shell gland and ocellus present (fig. 2). Postabdomen conical in lateral view, slightly lobular near the distal end; abdominal setae long, two-jointed, born on a pair of papillae. Terminal claw with two basal spines, distal one larger than proximal. Postabdomen with 7 marginal denticles. Antennules of female with a basal part and one long slender flagellum (fig. 3). Olfactory setae 5-6 attached on one side end of so called basal part. Small tongue-shaped projection on ventral side of head. Intestine simple, terminating at distal end of postabdomen. Colour greenish-white but not transparent.

Length of female: 0.98-1.1 mm.

MALE: Unknown.

Types: One female holotype and five female paratypes, collected from temporary water pool near Sahastradhara, Mandla, M.P., India, by Narendra Rane on 25.3.1981, deposited in the National Zoological Collection, Zoological Survey of India, Calcutta. C 3485/2, C 3486/2. All types are preserved in 5% formalin.

Latona narendrai sp. nov. differs from *L. tiwarii* Biswas, 1964 in its smaller size (for *L. tiwarii* length, 1.82 mm), larger head, centrally situated eye and less number of marginal denticles on postabdomen. *L. setifera* (O. F. Muller), 1785 and *L. parviremis* Birge, 1910 are large and more elongated species (Length: 2-3 mm and 2.5 mm respectively). They differ from the present (new) species in the structure of antenna which has very large and small antennary expansion. There is also great difference in setal formula of all four species, which is $\frac{10\text{-}11}{0\text{-}1\text{-}4}$ for *L. setifera;* $\frac{5\text{-}8}{0\text{-}1\text{-}4}$ for *L. parviremis*; $\frac{10\text{-}10}{0\text{-}1\text{-}4}$ for *L. tiwarii* and $\frac{5\text{-}7}{0\text{-}1\text{-}4}$ for *L. narendrai. Latonopsis australis* Sars in general appearance resembles *L. narendrai,* but the distinct dorsal impression between the head and trunk and tongue-like expansion at the ventral side of head are adequate to confirm the status of this new species. The three long setae on the post-ventral corner of the shell are a conspicuous feature of *Latonopsis australis,* but in place of them there are 8-10 large equal setae in the new species (Thomas 1961).

ACKNOWLEDGEMENTS

This work was carried out under a project of the Zoological Survey of India. I am grateful to Dr. K. Reddiah, Officer-in-Charge of Central Regional Station, Jabalpur for facilities and to Sri R. K. Singh of this office for his suggestions and guidance.

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A NEW *ISCHAEMUM* LINN. (POACEAE) FROM KERALA, INDIA[1]

P. V. Sreekumar, V. J. Nair and N. C. Nair[2]

(*With a text-figure*)

Ischaemum copeanum sp. nov.

Ischaemum burmanicum Bor affinis sed foliis angustioribus (*c.* 10 mm) ovato-lanceolatis, basibus foliorum cordatis, foliis inferorum numquam petiolatis, nodis barbatis, racemis 2, glumis inferarum brevioribus (*c.* 4.5 mm) differt.

Creeping annuals. Culms 20-40 cm high, creeping or geniculate; upper nodes villous, lower ones sparsely villous or glabrous. Leaves 2-5 cm long, 4-10 mm wide, ovate-lanceolate, acuminate, rounded or shallowly cordate at base, sparsely covered with tubercle based hairs. Sheaths 1-5 cm long, shorter than the internodes, striate glabrous. Ligule 1-2 mm, an ovate acute membrane. Inflorescence with 1-2 peduncules from a spathe, peduncles long exserted. Racemes two on each peduncle, 2-3 cm long, slender, sparsely villous. Joints of racemes 3.0-3.5 mm long, linear-clavate, coriaceous or chartaceous, densely villous along the margins and dorsal side. Lowest group of sessile spikelets in three, two of them are unawned. Unawned sessile spikelets 4.5-5.0 mm long, linear or oblong-lanceolate, single flowered, floret male; lower glume 4.5-5.0 x 1.0-1.5 mm, lanceolate when spread, chartaceous, silky villous in the lower half, hairs 0.5-2.5 mm long, margins infolded, scabrid towards apex. Awned sessile spikelet 4.0-4.5 mm long, ovate-acute, callus bearded; lower glume 4.0-4.5 x 1.50-1.75 mm, ovate-oblong, chartaceous, faintly 11-13-nerved, silky villous in the lower half, margins inturned, narrowly winged on one side, scabrid towards apex; upper glume 4.0-4.5 x 1.0-1.5 mm, boat-shaped, lanceolate when spread, chartaceous, sharply keeled, faintly or strongly 3- nerved, margins hyaline, ciliolate in the upper half; lower floret male; lemma 3.5-4.0 x 1.0-1.5 mm, oblong-lanceolate, delicate, hyaline, faintly 3-5-nerved, margins infolded, ciliolate in the upper half; palea 3.0-3.5 x 0.75-1.00 mm, oblong-lanceolate, delicate, hyaline, 2-keeled, 2-nerved, glabrous; stamens 3, anthers 1.5-2.0 mm long; upper floret bisexual; lemma 3.0-3.5 x 1.0-1.5 mm, notched, lobes acute, delicate, hyaline, faintly 3- nerved, awn 10-15 mm long, geniculate, column 4-6 mm long, brown, bristle pale, scabrid; palea 2.5-3.0 x 0.50-0.75 mm, oblong, delicate, hyaline, 2-keeled, 2- nerved, glabrous, with a few wart like dots towards apex; stamens 3, anthers 2.0-3.0 mm long, filaments short; ovary 0.4-0.5 mm long, oblong, styles *c.* 1 mm long, stigmas 1.0-1.5 mm long, feathery. Pedicelled spikelet 4.0-4.5 mm long, oblong-lanceolate or linear-oblong, unawned; pedicels 0.5-1.0 mm long, linear-clavate, densely villous; lower glume 4.0-4.5 x 1.00-1.25 mm, linear-oblong, chartaceous, densely villous in the lower half, margins narrowly inturned, scabrid towards apex; upper glume and florets similar in shape and structure to that of the sessile spikelet.

Holotype: KERALA, Cannanore District, Cherkala, ± 250 m, 24th November 1981, *P. V. Sreekumar* 71838 (CAL). Isotypes in K & MH.

[1] Accepted January 1984.

[2] Botanical Survey of India, Coimbatore-641 003, India.

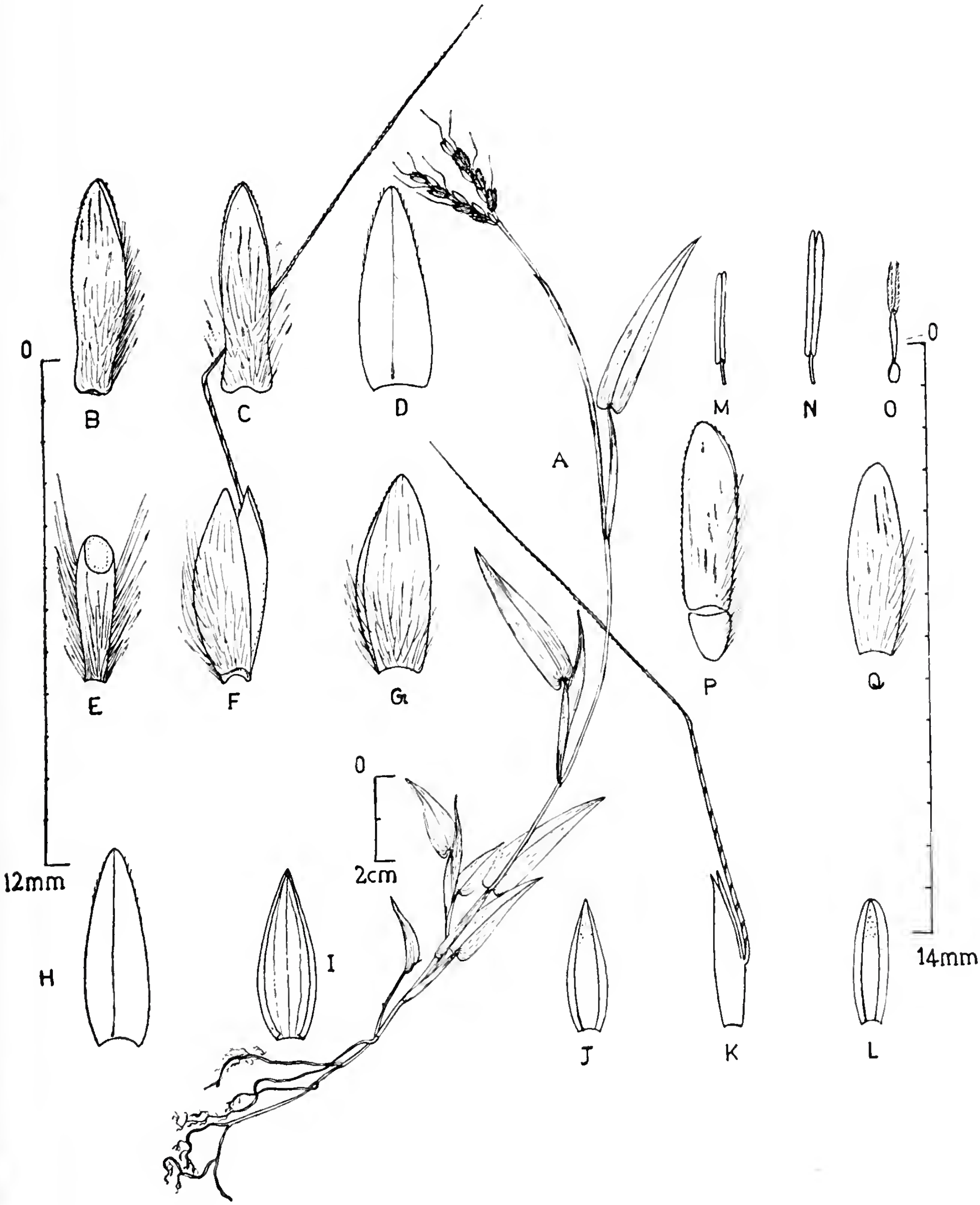

Fig. 1. *Ischaemum copeanum* sp. nov.

A. Plant; B. Unawned sessile spikelet (Dorsal view); C. Lower glume (Dorsal view); D. Upper glume (Dorsal view); E. Joint (Rhachis); F. Awned sessile spikelet (Dorsal view); G. Lower glume (Dorsal view); H. Upper glume (Dorsal view); I. Lower lemma (Ventral view); J. Palea (Dorsal view); K. Upper lemma (Lateral view); L. Upper palea (Dorsal view); M. Stamen of the lower floret; N. Stamen of the upper floret; O. Pistil; P. Pedicelled spikelet (Dorsal view); Q. Lower glume of the pedicelled spikelet (Dorsal view).

TABLE

Ischaemum burmanicum Bor	*Ischaemum copeanum* sp. nov.
1. Leaf blades up to 10 cm long, 15 mm wide, lanceolate, acuminate, lower ones shortly petioled, base sagittate	Leaf blades up to 5 cm long, 10 mm wide, ovate-lanceolate, lower ones not petioled, base cordate.
2. Nodes glabrous	Nodes bearded.
3. Raceme solitary on each peduncle	Racemes 2 in number on each peduncle.
4. Lower glumes of sessile spikelets — 6.5 mm long	Lower glumes — 4.5 mm long.
5. Lower glumes of pedicelled spikelets — 6.5 mm long.	Lower glumes — 4.5 mm long.

Slender, creeping or geniculate annuals growing in moist rocky places. A shade-loving species; locally rare.

This species is allied to *Ischaemum burmanicum* Bor, but markedly differs from it as shown in the Table.

The species is named after Dr. Thomas A. Cope of the Royal Botanic Gardens, Kew in recognition of his constant help throughout our studies on South Indian Grasses.

ACKNOWLEDGEMENTS

We thank Dr. Thomas A. Cope of the Royal Botanic Gardens, Kew for kindly examining our specimens and giving his opinion. Smt. C. P. Malathi has drawn the habit sketch.

MISCELLANEOUS NOTES

1. NOTE ON ASIATIC LION (*PANTHERA LEO PERSICA*)

The capture of large carnivora and their release again in their natural habitat has been a matter of debate and controversy for sometime. On a recent visit to the Gir forest (December 1984), I obtained the following facts which are relevant.

As is well known large lions live often in pairs in the Gir. There are many such pairs and probably the oldest among them is a pair believed to be 17 years of age and christened by the "shikaris" as "Akbar" and "Sultan". In May 1982, it was reported that Sultan was injured possibly in a fight with another male lion. He was located at Mundachowk. It was found that he had a large wound on his head between his ears, it had festered and was full of flies. His general condition was poor. His brother Akbar was in the same locality.

Sultan was lured into a cage with the help of a bait. Subsequently, he was transported to Sakarbagh Zoo at Junagadh a distance of about 50 km. from Sasan. He was treated there for six weeks until his wounds had completely healed. During his stay there, he took a dislike to the compounder who applied medicines to his wound and he was lured back into the cage by a simple expedient of making the compounder stand behind it. As the lion entered it to go for him, he found himself trapped in the cage.

Sultan was taken back to Mundachowk in the Gir forest and was released. Within 24 hours he had made contact with Akbar by roaring and teamed up with him. He took to his natural existence without difficulty and he was seen on natural kills of buffalo and cheetal alongwith Akbar. A watch was kept by the Forest department staff for a week after his release in case something unexpected happened. But nothing did.

I saw this lion in the Gir, he has obviously aged and looks much older than what I had found him the last time I saw him in 1978. His teeth are intact but badly worn. His mane was cut for treatment, while it has grown again, it does not have the splendour of its luxuriant growth of his pre-injury and youthful years.

In the early 70s there was another pair of large male lions christened "Ubhdo" and "Bhilio". In this case one of the lions Ubhdo, was removed to Junagadh for treatment to the injuries he had received in a fight. He was treated there but was not released in the jungle after his wounds had healed. It is interesting to note that Bhilio followed the truck carrying Ubhdo to the edge of the forest before giving up.

In September 1983, a female cub of about 3 months' age and which belongs to a pride of about 20 lions, fell in an open well near Dhanej in the forest. It spent nearly 24 hours in it before it was pulled out on a "khatla" (village bed). The cub was removed to Sakarbagh Zoo for treatment where it was nursed back to health in 6 weeks.

It was taken back to Gir forest, the pride in question was located and it was released within sight of it. The cub went straight to 3 lionesses, one of whom promptly accepted it and licked it. I saw this cub living with the pride on this visit, i.e. more than one year after

its return to the jungle. It has become a healthy animal.

The information I have given here was obtained from Mr. D. S. Narve, Dy. Conservator of Forest (Wildlife) Gir, and Shri Abhla Bha, a shikari who was involved in the trapping, treatment and release of Sultan.

DIVYABHANUSINH

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January 4, 1985.

2. AN OBSERVATION OF LYNX IN NEPAL

On 6 June 1975 a single adult lynx (*Lynx lynx*) was observed in the western Dhauligiri Range of north-western Nepal (28°46′N, 83°01′E). The location was in the upper valley of the Seng Khola, about 30 km north of the village of Dhorpatan. The elevation of the sighting was about 4500 m. Vegetation in the vicinity was alpine tundra dominated by various sedges and grasses. More detailed descriptions of the area can be found in Wegge (1979) and Wilson (1981).

The lynx was first seen close to the valley bottom about one kilometre downstream of the river's emergence from glaciers at the valley head. It was observed with 7 x 35 binoculars at a distance of 50-200 m for about two minutes as it crossed the river on large rocks and disappeared quickly up and over a steep hillside. The lynx was golden-brown in colour and had no distinctive markings.

Only one collection of lynx has been made in Nepal, and that was from the Mustang area (Mitchell and Derksen 1976). The present observation was about 80 km west-southwest of the above collection site. No other reports on lynx occurrence in Nepal are apparent in the literature. Further observations are needed to document the range of lynx in Nepal. Lynx probably occur throughout most of Tibet (Ellerman and Morrison-Scott 1966, Prater 1971), so their presence in northern Nepal is not surprising. A very sparsely distributed population of lynx probably exists across the far northern parts of west Nepal, generally north of the Great Himalaya Range.

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3. A POSSIBLE SIGHTING OF BLANDFORD'S FOX (*VULPES CANA*) IN KUTCH

Flying low in a helicopter in January, 1984 a pair of foxes were flushed in one of the smaller islands south of the "Island" of Khadir, in the Great Rann of Kutch. We flew for some distance hovering close over the fleeing animals and had an excellent view. The dark tail tip excluded the possibility of either the white-footed fox (*Vulpes vulpes pusilla*) which occurs in Kutch, or an aberrant Rüppell's sand fox (*Vulpes rüppelli*) which has not been recorded there.

The animals which we saw were larger than the Indian fox (*Vulpes bengalensis*) which also occurs in Kutch, with tails much longer and heavier-furred than those of the Indian fox and with very prominent black tips. The tail in fact was almost as long as the body and the 'Bush' as heavy as that of the Himalayan red fox (*Vulpes vulpes montana*) in winter, but of course of a different colour. The body coat was also heavier than that of the Indian fox and had a distinct greyish brown sheen. The ears were also noticeably larger. There were conspicuous dark markings on the lower parts of the face and on the limbs. M.K.S. Himmatsinhji of Kutch who is a keen naturalist and was with us on the flight, agreed with me that they did not appear to be Indian foxes.

All the physical characteristics barring one seem to indicate that they were Blandford's or Hoary foxes (*Vulpes cana*). The one exception is the size. Blandford's foxes are described as having bodies as small as that of the Indian fox, even smaller. There is, however, no other known species or subspecies of fox which comes nearer in approximation to the animals we saw.

The known south-eastern range of Blandford's fox is Baluchistan and possibly Sind in Pakistan. I have not come across any record of its occurrence in any tract south of the Indus. It is however just possible that its range may have extended further south-eastward than now, and relict populations may survive on the hilly and very wild tracts along the southern flanks of the Great Rann of Kutch, where due to the extreme remoteness of the terrain and low human population, the affinity in appearance, to the undiscerning eye, that this fox has to the common Indian fox, and the fact that no real mammalogical survey has been carried out in these areas, may account for it not having been located here. Or it is possible that a discreet population of the Indian fox has in this remote area evolved a physical form or race which differentiates it from the animal

met with elsewhere in India. It would be interesting to know whether the common form of the Indian fox is also met with in these parts. At any rate, it would be interesting to get a "feed-back" on this note, particularly from our naturalist friends in Pakistan.

M. K. RANJITSINH

THE PALACE,
WANKANER, SAURASHTRA,
February 3, 1984.

4. ON THE EXTENSION OF RANGE OF THE VESPERTILIONID BAT — *PIPISTRELLUS PATERCULUS* (THOMAS) TO POONCH VALLEY (JAMMU AND KASHMIR STATE)

Vespertilionid bats of the genus *Pipistrellus* (Kaup) are widely distributed in Jammu and Kashmir State and comprise about 25% of the total chiropteran fauna of the State. The common species of bats of the genus *Pipistrellus* (Kaup), which I have recorded from this State so far, are: *Pipistrellus pipistrellus* (Schreber), *P. kuhli* (Kuhl), *P. coromandra* (Gray), and *P. mimus* (wroughton). All from Kashmir Valley (Nath 1979).

During the course of extensive collections of bats made by me in Poonch Valley (Jammu Province) during 1971-1972, three specimens of the species *Pipistrellus paterculus* (Thomas) were obtained from a fairly-deep hole in a tree stump near an old uninhabited building in Poonch town. The present report is a new record for the State and also extends the range of distribution of this species further westwards from Burma and Bihar, as given by Sinha (1983).

I am thankful to Dr. J. E. Hill of the British Museum of Natural History, London, for confirming the identification of the specimens.

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5. THE REFLECTED GLOW FROM THE EYES OF THE LARGE RED FLYING SQUIRREL (*PETAURISTA PETAURISTA*)

On 29th May 1984 we were camping at a forest guard's hut at 10,200′, surrounded by thick oak forest at Manzi, 6 km below Dodital in the Uttarkashi dist. of Garhwal.

At late dusk while we were struggling with the campfire, my attention was drawn to a large object which glided and landed on a tree near the tents. Quickly a 4-cell commander torch was obtained and focussed on the animal which as suspected turned out to be a Large red flying squirrel (*Petaurista petaurista*). The torch was focussed on the squirrel at a distance of 20 feet. In the beam its eyes shone bright orange red. Later even when it climbed up, its eyes shone brightly as it turned to face the beam.

I do not know whether the colour of eyes when reflected of this particular species is recorded before, otherwise it may be an additional character for the field identification of the species.

3, Rocky Hill,
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NITIN JAMDAR

6. A NOTE ON THE FIELD RODENTS OF MANDSAUR DISTRICT, MADHYA PRADESH

(*With three text-figures*)

It was reported by the farmers that the field rodents were ravaging wheat crop and the estimates of losses ran to 50 per cent of the expected yield at Malhargarh (Distt. Mandsaur, M.P.). A small scale campaign was launched (14 to 18.3.76) by me to demonstrate and manage the rodent pests in the standing crops of wheat, gram and opium poppy. These field rodents were controlled following the technology as outlined in a supplement (published by Central Arid Zone Research Institute, Jodhpur) to the National Programme for Rodent Pest Management (Prakash 1976). The burrows were also dug out for studying the burrow patterns. The dead rodents were collected, preserved in 10 per cent formaldehyde and later identified at the Central Arid Zone Research Institute, Jodhpur. Present note embodies information on the field rodents of Madhya Pradesh with respect to their taxonomy, distribution, general habits, habitat preference, burrow patterns, breeding and hoarding behaviour.

Vandeleuria o. oleracea (Bennet), The tree mouse : This arboreal rodent was found dead under a large banyan tree (*Ficus indica*) near a wheat threshing floor. Previously it has been reported from Gwalior region (Ellerman 1961). Present record, thus extend its range further to north west. This rodent was not found to breed at the time of this study.

Golunda e. ellioti (Gray), The bush rat: They were observed to be crepuscular in habit and generally preferred to inhabit the hedges

of the garden located between the crop fields from where they had an easy access to the standing crops. They were also recorded to devour the gram pods which were heaped in the field for drying. These rodents had quite simple burrows (fig. 1), only two bulbous structures connected by a horizontal gallery.

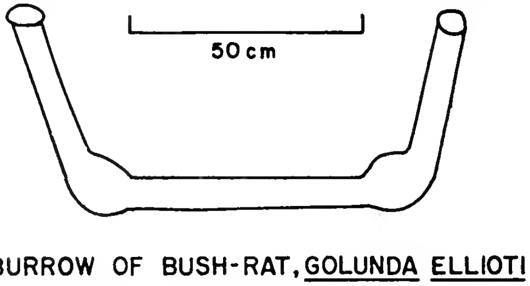

Fig. 1. Burrow system of Bush-Rat, *Golunda e. ellioti* in Madhya Pradesh.

Whenever, I tried to observe their feeding behaviour in the standing wheat crop, they immediately entered the burrows of *Rattus m. meltada.* They were seen to move about on distinct runways and this proved to be the best place for baiting them. I was able to collect their young also from the hedges, underneath the dried leaves. They were estimated to be about two week old as the fur had developed. These were lying outside the burrow opening and one young and partly devoured skull indicating cannibalistic habit of this rodent species. This appears to be the first record of a rodent species being cannibalistic under natural conditions.

Rattus m. meltada (Gray), The soft-furred field rat: This nocturnal rodent was relatively abundant in all the crop fields and was also

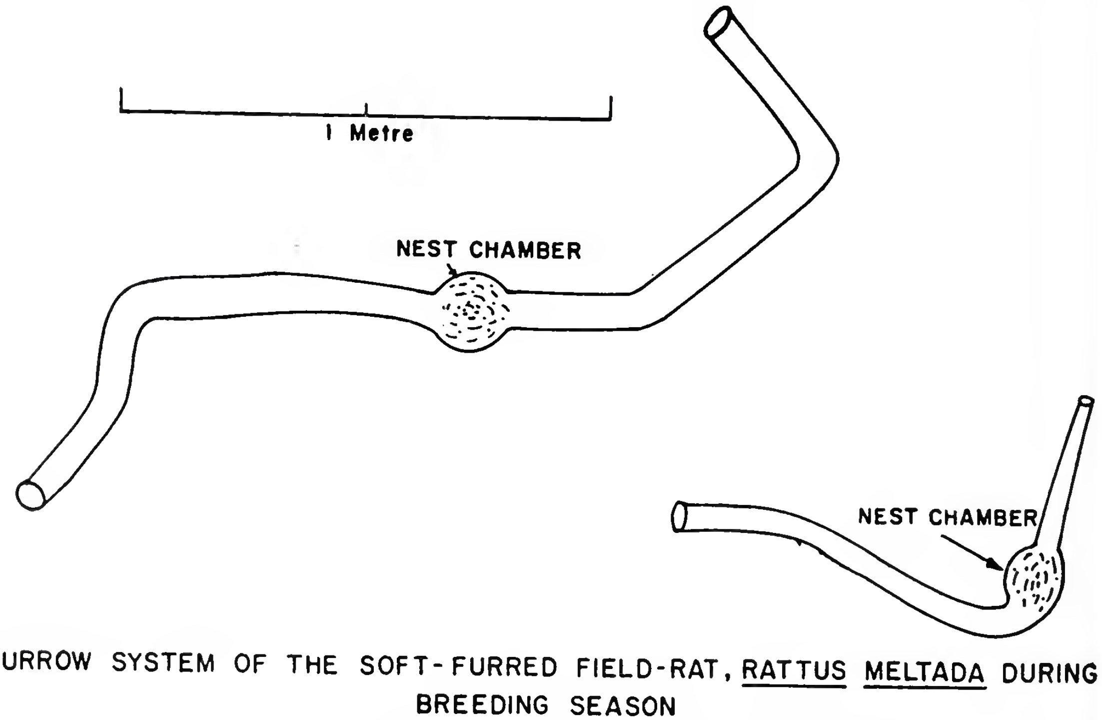

Fig. 2. Burrow system of *Rattus m. meltada* in Madhya Pradesh.

collected from lucerne fields. Their burrows were found to be quite simple (fig. 2) with a central nesting and resting chamber. No bolt run, as described by Barnett and Prakash (1975) was observed in all the burrows excavated. In one case, where a litter of five young ones (one juvenile was captured outside the burrow opening, staggering as the legs were unable to sustain weight of the body and its eyes were open) was recovered along with its dead mother, a small opening in the burrow was presumably provided for the juveniles. I collected these young ones one by one from the same arm of the burrow where the small opening was provided. They were squeaking trying to come of the burrow and were in a queue, quite way from their dead mother lying in the central chamber.

Bandicota b. bengalensis (Gray), The lesser bandicoot rat: Its identity was obvious from the large number of heaps of soil excavated at each burrow opening. The burrows were invariably plugged and located right inside the wheat fields. They had distinct runways also. Each burrow system had 12-16 openings on an average. Chakraborty (in press) record-

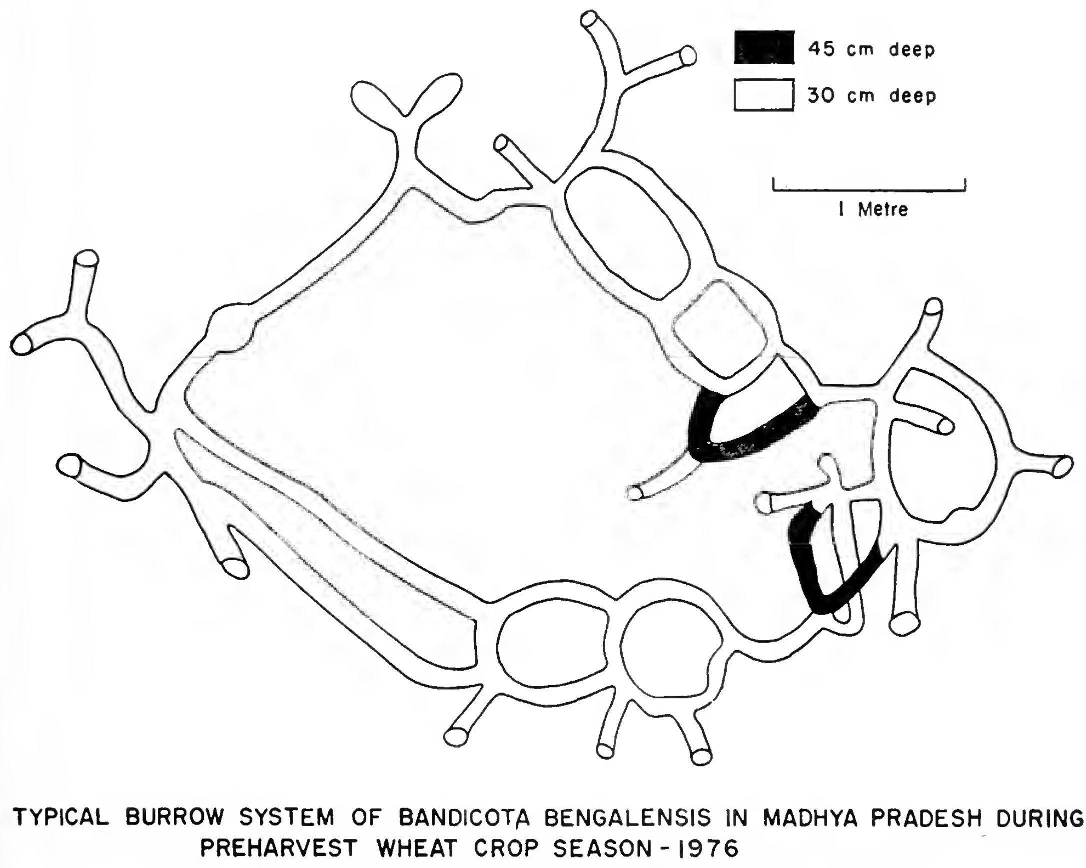

Fig. 3. Burrow system of *Bandicota b. bengalensis* in Madhya Pradesh.

ed 1-10 openings in Bengal. The burrows were labyrinthine, complicated and well architectured, were comparatively wider (fig. 3). to accommodate the large body size of the bandicoots. They were normally 30 cm deep and had resting chambers at 45 cm depth. I actually recovered them from the nesting chambers after zinc phosphide baiting. The burrows had distinct granaries. However, certain previous reports did not include such granaries in the burrow system (Barnett and Prakash 1975). Probably these burrow systems were studied either before pre-harvest period or during non-cropping season. But Chakraborty (in press) and Roy (1974) have described this system from Bengal and Bihar in some detail. My study indicated that the burrow system is 5.5 metres long on an average, whereas in Bengal it is 7.5 metres (Chakraborty in press) and 45 metres (Deoras 1964) and 10 metres (Kamath 1961) in Bombay State.

Hoarding behaviour: It is a fairly common and characteristic feature of the life of the lesser bandicoot rat prevalent particularly during pre-harvest period. On an average 3.69 kg of (de-husked) wheat was recorded by me to be hoarded per burrow system. In Punjab these bandicoots hoarded 7.3 kg of wheat ears per burrow (Sood and Guraya 1976). Chakraborty (in press) in Bengal, also recorded these values to be 3.20 kg. for paddy. But Roy (1974) evaluated 0.53 kg paddy for each burrow in Bihar. So in the wheat field under observation (0.65 hectare), total number of such burrow systems recorded were 47 and thus the total amount of de-husked wheat come to be 173.43 kg or 267.59 kg per hectare. This amount is apart from what the free living population of these bandicoots was consuming. But Greeves *et al.* (in press) reported a hoarding capacity of bandicoots in Pakistan to be 100 kg of paddy per hectare. Looking at the considerable differences in the data so far available on hoarding activity, detailed studies may be initiated to evaluate the actual loss which these bandicoots exact throughout the country.

Another interesting feature of hoarding is that the bandicoots arrange wheat ears in a anticlock-wise centrifugal-concentric direction. Further, they had cut all the ears approximately equidistant, i.e. 1 cm from the base. Roy (1974) also recorded similar behavioural pattern. Obviously then, this becomes a fixed behavioural pattern of these bandicoot rats. Furthermore, these bandicoots had partly buried the ears outside their burrow openings possibly for drying. Not only this, in certain arms of the burrow system ears had thin lining of the soil over them and again ears were arranged. Due to heavy winter rains wheat had germinated in certain pockets. Besides, straw of wheat plants was also found in appreciable amount inside the burrows. No apparent sign of consuming the hoarded wheat ears was encountered, possibly the free living population of these bandicoots was being maintained by the standing crops.

Survival value of hoarding: It has been stated that hoarding simply provide a cache from where young rodents can get the food at a shorter distance without being exposed to predators (Jackson 1966). My contention is that the hoarded food is ample enough to tide over the lean period, particularly for young rodents. But Roy (1974) maintained that the hoarded rice is never consumed by the bandicoots and eventually the cache is either dug up by local people or left to rot. In my opinion these bandicoots possibly do not migrate either to bund or to other fields, because here the next crop is scheduled only in the monsoon. Since Mandsaur area comes under semi-arid zone, the rains too, are not heavy so as to

compel these rodents even to migrate to bunds.

A single bandicoot consumes 13 g of food per day but hoards 67 g per day under captive conditions (Parrack 1969). The present study, however, indicates that 3690 g of wheat grains were hoarded in a burrow which was shared by two adult and two sub-adult bandicoots, and if these figures are superimposed to Parrack's data it would be clear that on an average the daily consumption of these four rodents dwelling in a burrow will be about 36 g per day. Thus the hoarded wheat should be sufficient to live on for 102.5 days. The next crop in the study area (maize or sorghum and other pulses) is scheduled roughly after 90 days and this period can easily be passed safely without being exposed. This hoarded material remains safe inside the burrow even when the fields are prepared as plough can hardly probe 30 cm deep into the black cotton soil.

Funambulus pennanti (Wroughton), The five striped palm squirrel: This arboreal rodent was fairly common in the orchards as well as in the vegetable and crop fields. However, religious taboos still do not permit the killing of this potent rodent pest.

ACKNOWLEDGEMENTS

Dr. H. S. Mann, Director, Central Arid Zone Research Institute very kindly provided laboratory facilities, for which I am thankful. I also feel highly indebted to Dr. Ishwar Prakash, Animal Ecologist for his painstaking guidance in the identification of the rodents.

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7. TOOL-USE BY ELEPHANTS

There are about a dozen instances of tool-use by elephants on record (Beck 1980). These pertain to both wild and captive individuals of the two extant species *Loxodonta africana*, the African elephant, and *Elaphus maximus*, the Asian elephant. Most examples refer to the use of sticks and other objects in body care, but there is a record of an African elephant using a twig to extend its reach to food. There are also examples of elephants throwing various materials. The aims of this communication are 1) to draw readers' attention to a mid-nineteenth century reference to a possible case of tool-use by an Asian elephant; and 2) to put on record a new instance of elephant tool-use which is unique as it differs in one important respect from other recorded instances of tool-use by these animals.

Henry Metcalfe, a private serving in the British army in India described the following incident which he witnessed in 1852 (Tuker 1953).

"Perhaps it will not be out of place here to relate a little incident in which the obstinacy and sagacity of the elephant was displayed. We were crossing the Cabul River (a very rapid river). We had two elephants drawing a heavy siege gun. When we came to the brink of the river the elephants would not budge a peg further, not even when urged forward by the native drivers' spears. When the Commandant of the Artillery found they would not move, he ordered up the master elephant to see what effect that would have on the refractory ones, but not a bit of notice would they take of him. Well, the master elephant had a tremendous thick chain attached to his trunk which he shook in the face of the stubborn ones, but not a move. At last tired of remonstrating, he belaboured the two elephants with this chain till their roars could be heard miles off. The chain had had the desired effect. Without waiting for a repetition of the chain, they plunged through the river with their load, and we had no trouble with them."

If this is an accurate description of what the author saw then as far as I am aware it is the earliest recorded instance of elephant tool-use.

On 7 November 1983 at Amber in the state of Rajasthan, India (27°00′N 75°51′E) three elephants passed me on the road, each carrying a load of straw on its back. The second of these also held a small bundle of straw in its trunk. When this elephant was about 15 m from me it flicked its trunk up smartly with the consequence that the straw struck its right ear. The end of the little bale hit the ear with some force and the blow seemed to be a well-aimed one.

In all but three previously recorded observations of elephant body care where the animal used an implement as an extension of its trunk the part of its body involved could not have been reached with the trunk alone. In the other three examples it is not clear whether or not the animals concerned could have reached their target using only the trunk. The example of elephant tool-use reported here is unique in that the part of the animal's body which was struck with the straw (the ear) was within reach of its trunk. I saw no swarms of flies around the elephant's head, so if it was warding off an insect then the most likely type would have been one that was difficult to remove with a mere wave of the trunk or ears. As the ears contain many blood vessels then perhaps a blood sucking parasite was the culprit — one that would require a firm strike to dislodge. The elephant could easily have carri-

ed the little amount of straw held in its trunk on its back, therefore it seems possible that the elephant had been given this small bale for the specific purpose of repulsing insects.

This observation also provides a clue to the possible discovery of this category of tool-use. If an elephant is carrying something in its trunk and then attempts to deflect insects from its body using its trunk then the material carried fortuitously becomes a tool as it nears the insects. Via simple reinforcement principles the animal might then learn to use implements as fly whisks.

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8. THE BLACK STORK IN KUTCH: OLD RECORD CONFIRMED

I saw two black storks on November 25, 1983 at Pragsar Lake in the Chadva range of hills, about 24 km west of Bhuj. One of them was in adult plumage, while the other appeared to be a juvenile. Sálim Ali's survey did not meet with *Ciconia nigra* and I, during my bird watching trips or otherwise, have not come across it over the last 35 years or more in Kutch. Capt. C. D. Lester recorded this stork as a cold weather visitor in this area, but this was in late 19th or the beginning of the present century. Darbar Saheb Shivrajkumar Khachar informed me that he has recorded the Black Stork often in Jasdan.

Similarly, I saw a spotted Redshank *Tringa erythropus* on the village tank of Lodai on January 26, this year. This wader too has eluded the various surveys in Kutch. Nevertheless it finds a place in the appendix on page 171 in the BIRDS OF KUTCH.

JUBILEE GROUND,
BHUJ, KUTCH,
February 29, 1984.

HIMMATSINHJI

9. OCCURRENCE OF BAER'S POCHARD (*AYTHYA BAERI*), IN BHARATPUR, RAJASTHAN

On the second March 1984, at about 8.30 a.m., as I was watching waterfowl and other aquatic birds in the marshes of Keoladeo National Park, I noticed a dark head of a duck

standing out from the grass about a hundred feet away. On closer examination with my 10 x 35 binoculars, I realised that the head was not black as it appeared from the distance, but was dark glossy green. The eyes were contrastingly pale, and when the duck made a move, I had a good view of the breast which was rich rufous-chestnut sharply demarcated from the whitish underparts. The bird was later identified as Baer's pochard.

The pochard always kept company with a group of Ferruginous ducks (*Aythya nyroca*), and this greatly facilitated comparison. I could well make out that Baer's was a bit larger and had a faster flight than the latter. The duck was always seen resting in watery grassland, at times awkwardly waddling about to forage. I saw the duck once again the next day and also on the 7th, 9th and the 10th of March. On all these occasions, it was invariably in company of the flock of *Aythya nyroca* and was seen in the very same spot where it was first noticed.

Baer's pochard is recorded as "an uncommon and erratic winter visitor to Manipur (fairly regular), Assam, West Bengal, and Bangladesh"! (Ali & Ripley 1978). Thus the occurrence of this duck in Bharatpur, so far from its normal distributional range seems noteworthy.

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REFERENCE

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10. SOME SPARROW-HAWKS (*ACCIPITER*) FROM INDIA

Through the courtesy of Messrs. H. Abdulali and S. A. Hussain, I was recently able to examine a further small number of sparrow-hawks from the collection of the Bombay Natural History Society. The following specimens merit discussion, as providing information supplementary to that given in my previous paper (Mees 1981).

1. *Accipiter virgatus affinis* Hodgson. ♂ ad., 23.i.1969, Bharatpur, Rajasthan, leg. BNHS bird banding camp (BNHS no. 23587). Measurements: wing 167, tail 124, tarsus 54, middle toe without claw 30, bill from cere $10\frac{3}{4}$, wing tip 40 mm. Tail/wing 74.2%, wing tip 24.0%. The black streak on the throat of this specimen is rather weak, although fluffy as it should be, but in every other respect, this is a thoroughly typical specimen of *affinis*.

The present specimen is important as providing the first definite record from the Indian Plain; all earlier records have either been shown to be erroneous, or could not be verified. Previously, I gave as my opinion that this subspecies has mistakenly been regarded as being migratory. It might be thought that the new record now provides evidence for migration. Whereas there is obviously some truth in this, two other possibilities seem more likely

to me. One is that *A. v. affinis* is a resident at Bharatpur, where the famous sanctuary might well provide suitable habitat for it, the other that the specimen was a straggler (like the specimen of *A. v. besra* from Bhavnagar, mentioned in my previous paper).

2. *Accipiter virgatus kashmiriensis* Whistler. ♂ ad., 5.iv.1926, Ranikhet, leg. F. E. W. Venning (BNHS no. 12700). Measurements: wing 165, tail 129, tarsus 52, middle toe without claw 30¾, bill from cere 11, wing tip 38 mm. Tail/wing 78.2%, wing tip 23.0%. This specimen is very pale on the under surface and also its upper parts, particularly the secondaries, are rather pale. Although I am still doubtful of the validity of *kashmiriensis,* it should certainly not be definitely rejected without further study. If the subspecies is valid, it ought to have a definable range. Further, I wish to draw attention to the fact that, according to Ali & Ripley (1968: 247) and Ripley (1982: 46), who recognise *A. v. kashmiriensis,* it "affects broken forest country', whereas the two other Indian subspecies, *A. v. affinis* and *A. v. besra,* inhabit "heavy forest". I would hesitate to accept the existence of such an ecological difference, without supporting evidence.

3. *Accipiter virgatus abdulalii* Mees. ♀ ad., 17.ii.1980, Interview Island, Andamans, leg. Sálim Ali (BNHS no. 26116). Measurements: wing 182, tail 132, tarsus 53, middle toe without claw 35, bill from cere 14½, wing tip 47 mm. Tail/wing 72.5%, wing tip 25.8%. This bird agrees entirely with the adult females previously described; it is very close to females of *A. v. besra,* but differs by having a slightly heavier bill.

Interview Island is a new locality for this subspecies, which previously was known from Middle Andaman and South Andaman.

4. *Accipiter gularis gularis* (Temminck & Schlegel). ♂ ad., 10.iii.1983, Point Calimere, leg. BNHS Avifauna Project (BNHS no. 26410). Measurements: wing 166, tail 111, tarsus 49, middle toe without claw 28, bill from cere 11, wing tip 52 mm. Tail/wing 66.9%, wing tip 31.3%.

This additional specimen from Point Calimere, from where there are two previous records, confirms the species as an apparently regular migrant visitor to that locality. It ought to be more widely distributed in India and is also to be expected in Sri Lanka (where else could birds passing Point Calimere go ?). The specimen is in an advanced state of primary moult, the two outer primaries on each side being short and in sheath.

Users of my 1981 paper should be aware that through an unfortunate error, the captions of the figures 1 and 2 have been placed sideways, and not at the bottom of the pages where it was intended that they would be. The references to top and bottom figures should be read as if the captions had been placed at the bottom.

G. F. MEES

Rijksmuseum van Natuurlijke Histoire,
Leiden,
February 13, 1985.

11. IMPERIAL EAGLE, *AQUILA HELIACA* SAVIGNY, IN MAHARASHTRA — A SOUTHWARD EXTENSION OF ITS WINTERING RANGE

Whilst visiting Nandur-Madhameshwar in Nasik District (40 km east of Nasik-Pune road) on 17th December 1983 we sighted a large raptor flying over open country in the vicinity of the River Godavari.

We noted the following field characteristics—

1. Overall plumage was blackish brown,
2. Pale tawny head — very distinct, even at long range,
3. Prominent white scapulars,
4. Yellow legs.

Our identification of this raptor as an adult Imperial Eagle was made after consulting the two field-guides we were carrying *A field Guide to the Birds of Britain and Europe* by Peterson, Hollom and Mountfort, and *Birds of Europe* by Bertel Bruun. This preliminary identification was confirmed on checking with the specimens and other reference material at the BNHS.

This bird is not listed in the "Checklist of the Birds of Maharashtra" (1981) by Humayun Abdulali. Ali and Ripley, (HANDBOOK Volume 1, p. 275) have stated "Rare resident (?)?, but mainly winter visitor. W. Pakistan (Baluchistan, Sind, NWFP), N. & N.W. India (Kashmir, Himachal Prodesh, Nepal) south to Gujarat (Kutch, Saurashtra). How much further east and south uncertain due to records being vitiated by confusion in field identifications. Affects open treeless country.

This sighting clearly indicates that the Imperial Eagle does stray south of its known wintering range.

13 NEEL TARANG,
210 V. S. MARG,
MAHIM, BOMBAY 400 016.
DEBI GOENKA

45/46 MADHURIMA,
M. G. ROAD,
KANDIVLI (WEST),
BOMBAY-400 067.
SUNJOY MONGA

131, MEHR-DAD, 13TH FLOOR,
CUFFE PARADE,
BOMBAY-400 005,
December 19, 1983.
KIRAN SRIVASTAVA

12. SAKER FALCONS IN THE MELGHAT

On the morning of 31st January, 1984, I saw a pair of falcons close to the Kukru rest house in Betul district of Madhya Pradesh. I was able to watch them through binoculars, both at rest and in flight and had an excellent view of them at a range of 30 metres. The pale head and face with the narrow dark streaks; the broad streaks on the ear-coverts; the dull brown-and-rufous back; the off-white belly and chest spotted with brown droplets, the dis-

tinctive white oval spots visible on the tail, and the body size identified the raptors as saker falcons (*Falco biarmicus cherrug* Gray, 1834).

The Kukru highlands are an open plateau 3700 feet above m.s.l. and are contiguous with and an extension of the Melghat of Maharashtra. The birds were hunting the grasslands on the top of the plateau. It would be interesting to find out whether this species has been recorded in this area, or further southwards or eastwards.

THE PALACE,
WANKANER, SAURASHTRA,
February 16, 1984.

M. K. RANJITSINH

13. OBSERVATIONS ON SPOONBILLED SANDPIPER (*EURYNORHYNCHUS PYGMAEUS*) IN ITS WINTERING GROUND AT POINT CALIMERE, THANJAVUR DISTRICT, TAMIL NADU

The Spoonbilled Sandpiper is a rare winter visitor to the Indian subcontinent (Ali & Ripley 1969). The occurrence of this species at Point Calimere has been reported earlier (Sugathan 1983). Dementiev & Gladkov (1969) have recorded some aspects of its ecology on its breeding grounds in Siberia but very little information is available on the ecology and feeding habits of the species in its winter quarters. During the winter months of 1982 and 1983 I had the opportunity of observing the feeding behaviour of this bird at Point Calimere. The species is very difficult to distinguish from the similar looking Little stint (*Calidris minutus*) and Dunlin (*Calidris alpinus*) when inactive. However, the birds can be readily recognised by their typical feeding behaviour which resembles that of the Spoonbill (*Platalea leucorodia*).

On November 17th 1982, while on a wader census I saw 13 birds roosting at the western end of the Vedaranyam swamp on a dry mudflat. Seven birds among these were slightly bigger than the Little Stint, and when seen through the telescope turned out to be Spoonbilled Sandpipers. For about 35 minutes the birds continued to remain stationary. The tide was slowly advancing and hundreds of Stints and Curlews Sandpipers were feeding along the waters edge, chasing each other and calling. The flock I was observing joined their companions in feeding. However, Spoonbill sandpipers did not join the others but confined themselves to feeding at the water's edge and on the dry ground, in a loose flock. They appeared to catch insects emerging from the crevices in the dry mud as the tide water seeped into these cracks. Most of the food items were pecked from the ground itself, but some were caught in the air up to about 4 inches from the ground. After about 10 minutes of observation some fishermen disturbed them and all the birds flew off. For the next one week despite intensive search I could not see them.

On the 3rd December 1983, a rainy day, we came across four waders feeding vigorously along a sandy shore at the sanctuary. The tide was receding. We could approach very closely and it was possible to see the spatulate bill of the single spoonbilled sandpiper among the 3 sanderlings (*Calidris alba*) even without a pair of binoculars. While the sanderlings were pecking food organisms from the exposed sand after the receding of the waves, the Spoon-

billed Sandpiper was seen making continuous scoops in a zigzag manner, raising its head from the sand to swallow the food particles at intervals ranging from 45 seconds to 3 minutes. I did not see it again during the following days, and thereafter the species was not met with in the area.

Altogether five birds were trapped for ringing at Point Calimere between Nov. 1980 and Dec. 1983. Out of these two were preserved in the BNHS collection.

The stomachs of the two birds collected were examined; they contained the following material:

Sample: 1) Weight: 5 g.
- Fragments of head and body of beetles.
- A few parts of Dipteran flies.
- 30 small sand particles.
- Three pieces of chironomus larvae.
- A few unidentified particles.

Sample: 2) Weight: 4.5 g.
- Mouth parts of water beetle.
- A few pieces of insect larvae.
- A few parts of a ground beetle.
- Tiny particles of a white hard substance (most probably fine particles of shell or calcium).
- 19 fine grains of sand with smooth surface. Greenish mass with unidentified particles.

The spoonbilled sandpiper can be easily overlooked among flocks of little stints and Sanderlings. Unless carefully looked for its occurrence in the wintering quarters is not often noticed.

It is clear from the above observations that the feeding zone of *E. pygmaeus* occupies a wide range of micro-habitats ranging from sandy shore to dry mud flats of the swamps. They appear to adopt three kinds of feeding methods: (a) long continuous scoops on wet sand of the tidal zone, while walking; (b) semi-circular side to side scoops standing at one place in the soft mud, followed by few steps and repeating the same procedure and (c) pecking food particles or insects from dry hard soil or catching them at ground level or in the air. From the stomach analysis it appears that they take beetles, flies, insect larvae, fine sand particles and some amount of calcium.

ACKNOWLEDGEMENTS

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August 17, 1984.

REFERENCES

ALI, SALIM & RIPLEY, S. DILLON (1969): Handbook of the Birds of India and Pakistan. Vol. 2, Oxford University Press.

DEMENTIEV, G. P. & GLADKOV, N. A. (1969): Birds of Soviet Union. Vol. III. Israel programme for Scientific Translations, Jerusalem.

SUGATHAN, R. (1983): Some Interesting aspects of the Avifauna of the Point Calimere Sanctuary, Thanjavur Dist., Tamil Nadu. *J. Bombay nat. Hist. Soc.* *79*(3): 567-575.

14. INDIAN WHISKERED TERNS *CHLIDONIAS HYBRIDUS* MOBBING A FEMALE BLACKBUCK *ANTILOPE CERVICAPRA*

A lone female Blackbuck *Antilope cervicapra* was observed being mobbed by four Whiskered Terns *Chlidonias hybridus* at the Great Indian Bustard Sanctuary, Karera (Shivpuri district of Madhya Pradesh), on 9th March 1983. I was doing the weekly bird census along a 2 km. stretch on the mud road in the scrub area — mainly *Zizyphus* sp. and *Acacia* sp. — between the villages of Fatehpur and Dihala. Just halfway along, the terns were observed flying from Dihala jheel, hovering and diving into the scrub. Their dives were accompanied by a loud cacophony from a neighbouring Large Grey Babbler *Turdoides malcolmi* flock on an *Acacia* sp. about 1.80 m. tall. Soon after, the doe burst out from behind a rise directly below the hovering terns. The road on which I was standing was about 0.6 m. higher than the open-scrub level and as such I was easily visible for a great distance. The doe ran for about 8-10 metres approx. and stopped with an alert look towards me. Each of the four terns dived at it while stationary but, without coming into contact. Their target seemed to be the doe's head and they pulled out of their dives when near it. Thus disconcerted, the doe ran ahead for 6-8 metres and stopped on the road, looking at me. The terns did not dive at the doe while it was running. The moment it stopped on the road, the terns repeated their performance making the doe run ahead towards Fatehpur. The doe soon went out of sight behind the rise, but I could follow its' movement by the flight of the terns and their occasional dives. The babblers however flew to an adjoining wheatfield and did not pursue the doe. They may have been apparently disturbed while foraging and hence raised their alarm.

Ali and Ripley (1983) mention that the Indian Whiskered Tern calls out in a sharp *kreak, kreak*, "especially when nesting birds are disturbed by an intruder and demonstrate agitatedly overhead. "During the period of my above observation, I did not hear the terns call out at all. The nearest breeding records with reference to Karera are for Delhi and Lucknow, the season being June to August and varying locally (Ali and Ripley 1983). I made a circum-trek of the Dihala Jheel — roughly 3 sq. km. — but could not find any evidence of nesting by the terns.

ACKNOWLEDGEMENTS

I would like to thank Dr. Asad Rahmani for comments on an earlier draft.

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SHAHEED BHAGAT SINGH ROAD,
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February 3, 1984.

REFERENCE

ALI, S. & RIPLEY, S. D. (1983): Handbook of the Birds of India and Pakistan. Compact Edition. pp. 189. Oxford University Press. Delhi.

15. OCCURRENCE OF THE SANDWICH TERN (*STERNA SANDVICENSIS*) IN INDIA — A RING RECOVERY

The Sandwich Tern was known to occur on the Mekran and the Sind coasts of Pakistan in some numbers (HANDBOOK 3: 70) and it was sighted three miles away from Veraval on the west coast of Saurashtra by Dharmakumarsinhji in May 1958 (*JBNHS* 55: 357). However no specimen has been collected in India so far, and, as far as I know, there was no recent sight record of this species. In this context, the following account of the recovery of a Russian ring in India is of special interest.

Mr. C. K. Krishnaprasad of Thundathil, Cherai, Ernakulam dist., Kerala (*c.* 10°00′N; 76°15′E), shot a bird and recovered a ring (MOSKWA, P-348.842) on 11th March 1976. The Centre of Ringing and Marking Birds, Moscow, informed the Society that the ring was put on a juvenile specimen of the Sandwich Tern at Krasnovodsk Reserve, Krasnovodsk Gulf, Caspian Sea, Turkmenian SSR, on 26th June 1975.

This recovery establishes the fact that the Sandwich Tern visits the western seaboard of India in winter. On account of its very similar appearance to the Gullbilled Tern *Gelochelidon nilotica* in winter, this species may have been overlooked so far.

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16. EUROPEAN BEE-EATERS (*MEROPS APIASTER*) IN KARNATAKA

In their HANDBOOK (compact edition 1983) Ali and Ripley refer to only one sighting of the European Bee-eater (*Merops apiaster*) in South India, viz. in Salem district of Tamil Nadu in 1952. In the past two years, in late February and early March, I have seen a small flock of between 5 and 7 European Bee-eaters, both adult and immature, in the Kanakapuram District of Karnataka, which is some 50 kms SSW of Bangalore. The birds were perched on electric wires, from which they were feeding, in an open, rather rocky and barren area, at least 2 kms from water and about 10 to 15 kms south of Kanakapuram. It was reported that they come each year and stay about 10 to 14 days. The last time I saw them (March 4, 1984) it was beginning to rain heavily and the birds were fluffing out their feathers for protection, thus not looking as strikingly colourful as on previous sightings. They were photographed (900 mm lens), but as I had no stand at the time results were a little blurred, though quite clear enough for definite identification.

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17 MILLER'S ROAD,
BANGALORE-560 046,
March 27, 1984.

ERIC J. LOTT

17. BEE HUNTING BY THE BLACK DRONGO

On February 13, 1984, I watched a pair of Black Drongos (*Dicrurus adsimilis*) hunting bees, a noted item of their diet (Ali and Ripley 1983), from a large hive of Rock Bees (*Apis dorsata*) hanging under the roof of a three storey college building.

An interesting style of hunting seemed to emerge, where one bird flapped past the hive while the second soon followed only to capture any disturbed inhabitants. The bird then returned to the ledge to batter the prey against the cement and then swallow the bee in one or two gulps. The birds also waited for the Blue Rock Pigeons (*Columba livia*) that roosted under the roof to take off or land in the vicinity of the hive, an activity that never failed to disturb atleast a few bees.

Incidentally, it is on this roof that a pair of Red Wattled Lapwings (*Vanellus indicus*) have been building their nests for the last five years, but unfortunately not a single brood has survived.

The drongos attracted my attention at about 5-30 p.m. by their Shikra-like call and in the half hour I watched them, the pair had eaten twelve bees.

124/9 ERANDAVANA,
POONA-411 004,
April 17, 1984.

TAEJ MUNDKUR

REFERENCE

ALI, S. & RIPLEY, S. D. (1983): Handbook of the Birds of India and Pakistan, Compact edition, Oxford Univ. Press, Delhi, London, New York.

18. THREE APPARENTLY NATURAL HYBRIDS BETWEEN WALDEN'S BARWING *ACTINODURA WALDENI* AND THE HOARY BARWING *A. NIPALENSIS*, IN THE COLLECTIONS OF THE BRITISH MUSEUM (NATURAL HISTORY)

The Barwings, genus *Actinodura*, are six species of small brown and grey babblers. The Taiwan Barwing *A. morrisoniana* is restricted to that island; while another four — the Streaked Barwing *A. souliei*, Spectacled Barwing *A. ramsayi*, Walden's Barwing *A. waldeni* and the Hoary Barwing. *A. nipalensis* — mainly replace each other over a range from southern China and North Vietnam, through Burma to the central Himalayas. The Rusty-fronted Barwing *A. egertoni* has a general range overlapping those of the last two, but mainly occurs at lower altitudes.

The subspecies of *A. waldeni* occurring from Manipur south to the Chin Hills, and in the Naga Hills, north-east Burma and north-west Yunnan, are brown above and rufous below, with grey heads. *A. w. daflaensis* Godwin-Austen 1875 of the North-east Frontier Agency of India and adjacent south-east Tibet differs in being pale greyish-brown on the throat, breast and belly, with whitish feather edges that give it a streaked appearance. The back is brown but the upper mantle is pale grey. The crown feathers are elongated, dark greyish-brown and tapering, with a very narrow pale margin. The sides of the head are grey, with whitish streaking on the ear-coverts.

This subspecies is closest in general appearance to *A. nipalensis* (Hodgson 1836) which replaces it from Bhutan to Nepal, occurring in similar habitats and at similar latitudes. The eastern population of the latter has been separated as *A. n. vinctura* Ripley 1950 on the basis of a broader black tail-band which is not relevant to the present discussion. *A. nipalensis* is a more uniform pale grey on throat, breast and belly. There is a blackish moustache streak and the ear-coverts are more uniform pale grey. There is no grey on the upper mantle. The elongated crown feathers have rounded tips and are dark brown with a pale stripe along the middle, palest along the rachis; with similar but less striking and less numerous pale streaks on the brown mantle.

When specimens of the last two species in the collection of the British Museum (Natural History) were studied, three were found to show some intermediacy and a slightly variable mixture of characters. These appear to be natural hybrids. They are :-

Specimen 1. BMNH no. 1937.1.17.294. Collector's no. 4036. Nyug La, Pachakshiri, S.E. Tibet. 10,000 ft. Female. Collected 7 July 1936 by F. Ludlow and G. Sherriff.

Specimen 2. BMNH no. 1949. Whi. 1.13,329. Pin La, Bompu La. Bhutil Hills, Assam. 7,050 ft. Male. Collected 14 March 1938. H. Whistler Collection.

Specimen 3. BMNH no. 1949. Whi. 1. 13,330. Dirang Dyong, N.E. Frontier Agency. 5,200 ft. Male. Collected 20 April 1938. G.S. Lightfoot Collection.

As the tabulation of principal characters (Table 1) shows, specimen 1 is more similar to *A. waldeni* and the other two to *A. nipalensis*, but with a mixture of characters. All three show the dark brown feathers with paler streaks along the rachis, but the streaks are darker and much less conspicuous than in *A. nipalensis.*

The throats and breasts show an intermediate condition in the light streaking. The mantles appear a little darker than those of the two species. In general they lack the pale streaks of *A. nipalensis*, but there is a slight indication of them on specimen 2 which has

TABLE 1

COMPARISONS OF SOME CHARACTERS OF *Actinodura waldeni daflaensis*, *A. nipalensis* AND THREE HYBRIDS

Plumage	*A. waldeni daflaensis*	Specimen 1	Specimens 2 & 3	*A. nipalensis*
Crown	Tapering, dark with pale margin.	Some taper, moderately dark, slight pale rachial streak.	Rounded tio, dark with slightly lighter rachial streak.	Rounded tip, dark with very pale rachial streak.
Ear-coverts	Grey, whitish streaking.	Grey, whitish streaking.	Grey.	Grey.
Moustache streak	Absent.	Absent.	Blackish.	Blackish.
Throat and breast	Dark streaking.	Moderate dark streaking.	Moderate dark streaking.	Plain.
Upper mantle	Grey.	Some grey, and brown.	Dull brown.	Warm brown with pale rachial streaks.

pale bases to feathers, with some tapering towards the rachis. Specimen 1 has a few, less obvious pale bases; and specimen 3 lacks them.

Specimen 3 shows some resemblance to *A. waldeni* in that the mantle feathers are greyer than those of the other two. On the last two these mantle feathers show faint and very fine transverse barring. In general the barred tertiaries of *A. nipalensis* are rufous in ground colour and those of *A. waldeni* are greyish. Of the three hybrids, specimen 3 resembles *A. waldeni* most in having the tertiaries greyish, specimen 1 is intermediate, and specimen 3 is rufous.

In addition to the diagnostic differences in the plumage of head, mantle and underside in the two species *A. waldeni* and *A. nipalensis*, they also appear to differ in their calls (Ali & Ripley 1972). However, the evidence of these three specimens suggests that hybridisation may occur at times in the wild.

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April 17, 1984.

REFERENCE

ALI, S. & RIPLEY, S. D. (1972): Handbook of the birds of India and Pakistan. vol. 7. Oxford University Press, Bombay, London, New York. pp. 236.

19. NOTES ON TRACKING AND TERRESTRIAL ACTIVITIES OF THE FRESHWATER TURTLE *KACHUGA TENTORIA* IN RIVER MAHANADI, ORISSA

(*With a plate*)

Introduction

During a study on crocodilians in the River Mahanadi, Orissa at least four species of turtles were observed resident in the river within the Satkoshia Gorge Sanctuary. These were *Trionyx gangeticus, Lissemys punctata, Kachuga tentoria* and *Chitra indica*(?) with the respective local names as "Chábedá Kainchha" (Chábedá = one which bites, Kainchha or Kaichha = turtle), "Panka Kainchha (Panka = mud), "Kurma" or "Andeicha Kainchha" (Kurma = turtle, hard; Andákára = oval), and "Bálerá Kainchha" (Bali = sand; Balera = a colloquial term for 'clumsy' — perhaps refering to clumsy spoor left on the basking site). Identification of *Chitra indica* was only during their basking. It is believed that more than one species of *Kachuga* may be occurring in the river.

Observations reported in the following had stemmed while identifying the various animal tracks leading out of or entering into the river. These tracks included those of gharial (*Gavialis gangeticus*), mugger (*Crocodylus palustris*), otter (*Lutra lutra*), soft-shelled turtles, hard-shelled turtles (*Kachuga*), and snakes. The method for identifying *Kachuga* tracks is described below. Also discussed are the methods of determining the direction of movement from the tracks, the various terrestrial activities and observations from the nest. All information were recorded in the 22 km stretch of river within the sanctuary.

Turtle Tracking

In the field a *Kachuga* track and an otter track may sometimes appear similar but these are not confused with the tracks of soft-shelled turtles where the hind flap trails behind the body and the body drag is heavily swept from behind continuously. In *Kachuga* and otter the pug marks are closely set. Indistinct and interrupted tail spoor may be seen in a track of male *Kachuga*. The tail drag in otters is very distinct and because of hair the track is swept lightly. Distinction between *Kachuga* and otter tracks finally rest on the examination of the pattern of lines drawn while shifting the limbs forward — these lines in otter are wider and curve before drawing close to the axis of locomotion (Plate 1 C).

Ordinarily a turtle track cannot be mistaken for a crocodilian track. Crocodilian tracks seldom lead much away from the river, and these are characteristically accompanied by distinct ('scaled') pug marks, tail spoors and/or body spoors showing the marks of individual scutes (Bustard and Singh 1977a, Singh, in press). A snake track is typical in being smooth, undulating and without any other body mark.

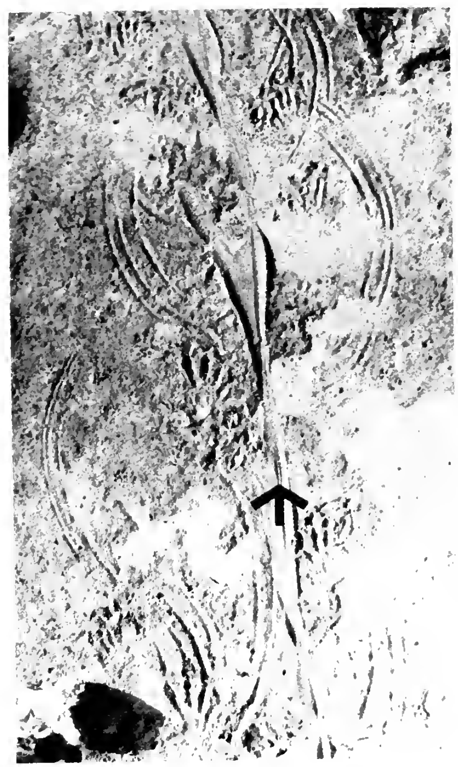
Direction of movement:

In *Kachuga* two lengths of lines are drawn by the limbs during locomotion (Plate 1 B). The longer ones are drawn when a limb shifts

A

B

C



A. Kachuga tentoria from Mahanadi.
B. Nesting emergence tracks of a *Kachuga* showing direction of movement (arrow).
C. Track of an otter showing direction of movement (arrow).

its position to a step ahead, and the shorter ones continuous with the former are drawn while bringing the limb closer to the body axis to support the body for forward propulsion. The longer lines are drawn forward and away from the locomotory axis. Therefore, the direction of movement is determined by finding out the direction in which the longer lines are drawn away from the centre of a track (locomotory axis). The lines, under good ground conditions can be counted to provide the count of claws. This technique has been found useful in determining the direction of movement of all clawed forms performing a bipedal or quadrupedal gait (see Introduction and Bustard and Singh 1977 b). The best time to study tracks is early morning or late afternoon when the sun is low in the sky.

Terrestrial Activities

The following are the types of terrestrial activities identified with *Kachuga* tracks in the sanctuary. (1) Tracks leading from drying water holes to the main river. These water holes are situated between the hill (mainland) and the river separated by continuous or broken flat sand banks. The water holes are formed away from the main river after floods. (2) Tracks from foot or middle of a sand bank to the main river. These are usually seen after unusual floods followed by quick recession. (3) Tracks of various lengths emerging from water over to sand banks and returning back almost parallel or rarely to a different point in the river. These tracks are inverted U-shaped and are normally associated with nesting activities. (4) Tracks leading from water to the foot-hill and getting 'lost'. (5) The normal diurnal activity of basking, mostly on rocky banks, half-submerged rocks or branches of water willows like *Salix*.

Table 1

Kachuga tentoria: Observations on the nesting in River Mahanadi at Tikerpada, Satkoshia Gorge Sanctuary, 1978

Nest no.	Date of laying	Nest location with respect to water		Area used for nesting (cm)	Nest dimension: maximum		Nest tempr. °C	Female body width (cm)	Clutch size	Mean egg		
		Distance (metres)	Height (metres)		Depth (cm)	Diameter (cm)				Length (mm)	Width (mm)	Weight (gm)
1.	5.11.	11.7	—	40x40	20	—	—	15	5	46.7	27.0	20.6
2.	5.11.	7.0	—	75x75	18	10	—	—	3	46.1	26.3	19.3
3.	6.11.	7.0	0.3	—	20	—	—	—	5	44.1	26.7	19.5
4.	7.11.	73.6	2.5	45x45	22	10	29	16.5	6	45.2	27.5	20.3
5.	7.11.	46.0	1.0	30x30	24	—	28.5	15.5	5	46.6	26.2	19.2
6.	7.11.	41.0* (23.0)	4.75	40x40	23	—	29.5	16.0	6	45.1	27.6	20.8
7.	9.11.	7.0	0.6	—	—	—	—	—	4	45.0	26.5	19.5
8.	11.11.	40.0	1.5	—	20	12	—	14.0	6	45.5	27.6	21.3

* Return tracks to a back-water closeby.

NESTING:

During discussions with local Kandha tribals and fishermen it was gathered that *Kachuga* in Mahanadi has two nesting seasons — one before winter during October-early November and the other after January. The Kandha tribals and jackals are the main predators for *Kachuga* eggs. Apparently, both these predators adopt the same method of tracking to the nest as discussed in the above. Olfaction may also be a help for jackals.

Eight nests were obtained between the 5th and 11th of November 1978 from the sand bank opposite GRACU. Data on nesting are given in Table 1. The nests were located at a along-the-ground distance of 7.0=41.4 m (n=8) from water and at a height of 0.3-2.5 m above the surface (n=6). The area disturbed for nesting varied from 30x30 cm to 75x75 cm (n=5). The depth of nest varied from 18-24 cm (n=7) and diameter 10-12 cm (n=3). Nest temperatures were recorded for three nests at 0800 hrs and it varies from 28.5°-29.5°C. The body width of females, measured from tracks, were 14.0-16.5 cm (n=5). The clutch size varied from 3 to 6 (n=8) and the egg length (n=40), egg breadth (n=40) and egg weight (n=40) were 45.5 mm (range: 43.0-48.0 mm), 27.0 mm (range: 26.0-28.5 mm) and 20.1 g (19.0-22.5 g range) respectively. The eggs were 10-12 cm below the surface.

Discussion

Gibbon (1970) found that nearly 30% of the aquatic turtles inhabiting a Bay in South Carolina (USA) exhibited some type of terrestrial activity and that these terrestrial activities included a considerable amount of time other than nesting. Migrations away from water have been associated with wintering by Cahn (1937), Cagle (1944), Carr (1952), Gibbon (1970), Bennett *et al.* (1970) and Bennett (1972). From observations on terrestrial activities of *Kachuga* presented in the above, movements from land to water are explicable as related to fluctuations in the water level (activities 1 and 2). While activities 3 and 5 are respectively for nesting and basking, activity 4 can perhaps be for over-wintering. However, more studies are necessary to confirm any over-wintering activity although the area experiences a minimum temperature as low as 4.5°C.

Tracking is a valuable means of studying animals for those aspects which offer limited opportunities to study otherwise. Lillywhite (1982) has rightly stated that "apart from early descriptive studies, a tracking approach has not been widely applied in quantitative ecological studies by herpetologists." Although the present paper, identifies the types of terrestrial activities in *Kachuga*, the subject remains wide open. The tracking procedure given in this paper is believed to form an useful guide for further field studies on the group.

Acknowledgements

I wish to record my gratitude to Orissa Forest Dept., Sri D. K. Sahoo and Sri I. C. Sahoo, Research Assistants at GRACU, and the Kandha tribals and Gharial Guards in the sanctuary for extending help. I am also thankful to Sri R. J. Rao, CRIR Senior Research Fellow at the National Chambal Sanctuary camp for his assistance during the preparation of the manuscript.

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February 11, 1984.

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20. CAPTIVE BREEDING AT BHAGABATPUR CROCODILE FARM, SUNDARBANS (WEST BENGAL), INDIA: THE CASE OF A WILD CAUGHT FEMALE (*CROCODYLUS POROSUS* SCHNEIDER)

INTRODUCTION

At the Bhagabatpur Crocodile Farm, Sundarbans (W.B.), a wild-caught female estuarine crocodile (*Crocodylus porosus* Schneider) mated with a captive male, smaller in size, and produced in 1982 a viable clutch of ten eggs from which two young ones hatched. This is the first captive breeding record of the species in India.

In India, the estuarine crocodile is known to occur in the mangrove-lined tidal creeks of Sundarbans in West Bengal, Bhitarkanika in Orissa and in the Union Territory of the Andaman and Nicobar Islands.

Since 1976 a captive rearing project of the State Government of West Bengal is in operation at Bhagabatpur for the conservation of Salt-water Crocodile. Sometime during May-July 1978 the Farm received a 2.56 m female crocodile that was rescued from a fisherman's net.

At Bhagabatpur farm each rearing pool is connected with the main branch of the river

Saptamukhi. Pools are flooded during the high tide and emptied during the low tide period. Enormous natural food enters during the high tide inside each pool. Pools are surrounded by *Rhizophora* sp., *Sonneratia apetala, Exocaria agallocha, Phoenix paludosa, Thespesia, populnea, Heritiera minor, Avecennia alba,* which simulates the natural surrounding.

During 1978 the female was first kept in a translocation pool where other crocodiles smaller in size to it were housed. The female established her territory and drove away the other crocodiles from the pool. So the female was shifted to a separate translocation pool in the beginning of 1979 and from that year onwards it was housed alone. It was fed with live goggled-eyed mudskippers (*Pohopthalmus* or *Boleopthalmus* sp.) crabs, frogs or toads, prawns and occasionally with domestic ducks and rats. The female was larger than any other male crocodile present in the farm.

Observations related to reproductive behaviour and growth of this wild-caught female are described in the following:

Observations

Egg-laying and hatching

During 1980 and 1981 the female was housed alone yet it produced eggs. At 2.64 m length in May 1980 although nesting materials were available, the female had dropped 16 eggs in water. Next year, on May 25th, the female (size: 2.86 m) constructed a nest mound (43 cm dia. x 45 cm high) of mud, weeds, grass, *Phoenix* and *Avecennia* (Hetal and Beno plants) and on 29th it laid 36 eggs in it. Eighteen of the eggs were found broken.

During the third week of April 1982 the female dug a passage into an adjoining pool where other crocodiles, including males 1.25-2.1 m long; were housed. A nest mound (71 cm dia. x 76 cm high) was completed on the 29th May and on 30th May (female size: 2.9 m) 10 eggs were laid in the nest. One of the eggs was spoiled, three were left in the nest and six transferred to an artificial nest. From the last six, two young ones hatched on 14th August after an incubation period of 76 days. Actual egg-laying was not seen in any of the years, but it is presumed that the act was accomplished very early in the morning.

During 1983 (female size: 2.95 m) broken egg shells were recovered from water and no other detail regarding nesting and egg-laying have been recorded. Earlier in the year, during the second week of March, the largest male had died and possibly successful mating had not occurred with any other male.

Fourteen eggs of 1981 clutch were measured and weighed: L x B x W = 6.4-7.5 cm x 4.5-4.7 cm x 51.8-65.9 g. One egg of 1982 with a partially developed young measured and weighed thus: L x B x W = 6.4 cm x 4.4 cm x 89.6 g; the maximum circumference along with width was 15 cm.

Nest-guarding behaviour

During 1981 and 1982 the female had zealously guarded the nest-mound either from an adjacent dug-out wallow or from the pool. At the sign of slightest disturbance, it used to lunge with open mouth and reach the nest in a single leap. During 1982 nest-guarding was seen throughout the incubation period.

Discussion

1. *Captive breeding*:

Outside India *C. porosus* have bred in captively Bangkok-1960 (Youngprapakon 1960), Higashi-Izu-1971 (Fukuda 1971), Singapore-1976 (Mitchell 1981) and Djakarta-1977 (Mackinnon 1981). As regards first captive breeding

in India the present report describes a situation where a wild female mated with a captive male and produced eggs during the 4th year of captive life.

2. *Reproduction*:

The first clutch of eggs was laid when the female was 2.64 m. In the absence of males the eggs in the first two years were infertile but the urge to mate was strong in the third year and it dug into an adjacent pool having a male, though smaller in size. Laying of the maiden clutch of eggs in the absence of a male *C. porosus* has been reported earlier by Acharjyo and Mishra (1981) in Nandankanan. Production of fertile eggs suggests that mating can be successful even if the male is younger and smaller than the female. This observation does not agree with Bustard's (1969) view that for successful breeding the male should always be larger. During 1980 and 1981 although the female laid infertile eggs, it had apparently not been attracted by the males. Perhaps the male saltwater crocodile reaches sexual maturity when at least 2.1 m long and 6-8 years old. The period between mating and egg laying is about a month and a half. The egg-laying season in captivity correspond with the period in the wild. Youngprapakon (1971) mentioned that the species reaches sexual maturity at the age of 12-15 years. Nest guarding from wallow have been recorded in captivity in the present set of observation. Such behaviour of *C. porosus* has been reported by Smith (1931), Loveridge (1946), Webb *et al.* (1977) Choudhury & Bustard (1979), Bustard & Kar (in press), Bustard & Maharana (in press).

3. *Growth*:

During the first two years after capture the crocodile had grown only 8 cm. The growth during the next three years were 6 cm., 4 cm. and 5 cm.

ACKNOWLEDGEMENTS

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21. A NOTE ON THE HABITS AND BREEDING OF THE LIZARD *JAPALURA MAJOR* (JERDON)

(*With a text-figure*)

A female *Japalura major* (Jerdon) was collected at Belak (Nr. Budhakedar) 8200′ Tehri Garhwal Dist., U.P. on 7th June 1984. This species is widely distributed in Western Himalayas (see Smith 1935). The Society's Collection has specimens from Nainital, Almora, Langira (Chamba), Simla, Lamgarh.

Boulenger (1885) described the colour of upper parts as olive and Smith (1935) as greyish brown. The specimen collected in Garhwal had grass green upper parts. The coloration according to Boulenger (1885)

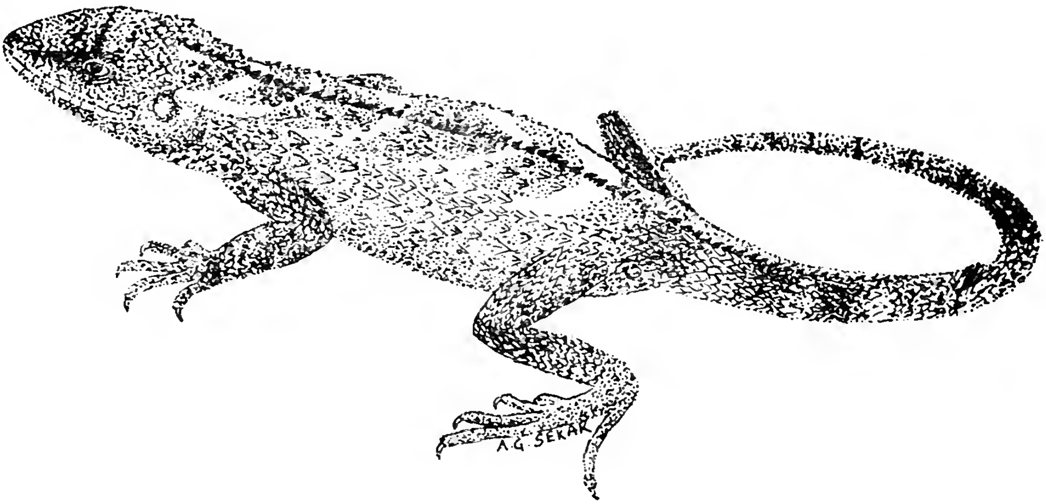

Fig. 1. *Japalura major* (Jerdon).

"Upper parts with dark brown, triangular or V shaped markings on back with apex directed backwards, flanks reticulated with blackish head from above with blackish cross streaks a oblique black band from eye to tympanum continued along the sides of the neck, limbs and tail with dark cross bars". Annandale (1907) records a patch of pale lilac scales under the throat. Measurements of the collected specimen — total length — 193 mm, head — 19 mm, width of head — 14.5 mm, fore limb — 27 mm, Hind limb — 45 mm, tail — 121 mm.

There is little information available on the habits of this lizard. The specimen collected by Annandale (1907) in the outskirts of Simla was sunning on bare rock by the road side and was very sluggish. The specimen collected in Garhwal was from an open grassy patch in the forest. Its grass green colour blended perfectly with the surroundings. It was sluggish, possibly because it was gravid. It was the only one observed in the trip.

I could not find any information on the breeding of this lizard. The specimen I collected had 10 eggs, five in each oviduct. The eggs were large for the size of the body, and were situated from the base of the tail to the fore limb. Eggs were soft, elliptical, and yellowish white in colour and measured as follows: 14.5 x 8 mm, 14 x 8 mm, 14.5 x 8 mm, 13 x 8.5 mm, 13 x 8.5 mm, 14 x 8 mm, 13.5 x 8 mm, 14 x 8 mm, 13.5 x 8 mm, and 14 x 8 mm. Average length 13.8 mm, average width 8.1 mm.

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22. ON THE STATUS OF *CHAMAELEON ZEYLANICUS* LAURENTI IN KUTCH

I come across the Indian Chameleon for the first time in Kutch in my garden here in Bhuj on 4 July 1984. On the publication of a press note about this occurrence in the local daily by the Pelican Nature Club of Kutch, there was a good response from the readers, giving useful information about the distribution of this reptile in the district. The Kutchhi name of *Chamaeleon zeylanicus* is 'sav sambho'. It appears from the information given, that it

exists in Kutch wherever there is certain amount of vegetation and scrub jungle. The chameleon I saw was uniform leaf green in colour with light yellow and dark green speckles and spots. There was no trace of either black or any other colour.

JUBILEE GROUND,
BHUJ, KUTCH,
August 18, 1984.

HIMMATSINHJI

23. RANGE EXTENSION OF THE SKINK *DASIA HALIANA* (H. NEVILL, 1887)

(*With a text-figure*)

On 18 August 1984, one of us (J.J.) was walking in the gallery forest along the bank of the Thambiraparani River, in Mundanthurai Wildlife Sanctuary, Tirunelveli District., Tamil Nadu, looking for lower vertebrates when we noticed a cluster of leaves on a *Manilkara hexandra* tree. The leaf cluster was of the creeper *Strychnos aenea* which is the dominant creeper species in this forest. At this moment a bonnet macaque happened to jump exactly on this leaf cluster and something green in colour was seen dropping down. It fell from a height of about 8 metres and a search of the area immediately thereafter proved futile. However about half an hour later a curious stump like projection was noticed on the sandy forest floor and surprisingly on being dug out, proved to be a skink.

The animal was very sluggish and did not even move when persistently teased for about ten minutes. When left alone it again buried itself in the sand but this time completely in about ten minutes. It was collected.

The gallery forest along the river is the only area in the Mundanthurai forests where one can see tall trees with thick foliage and large creepers with similarly thick foliage. There is good canopy continuation.

The skink was strikingly different in colour and pattern from species so far known in India and was identified as *Dasia haliana* a species till now considered as endemic to Sri Lanka. Annandale (1906), Smith (1935) and Deraniyagala (1953) describe this species as more or less arboreal in habits. The species is now

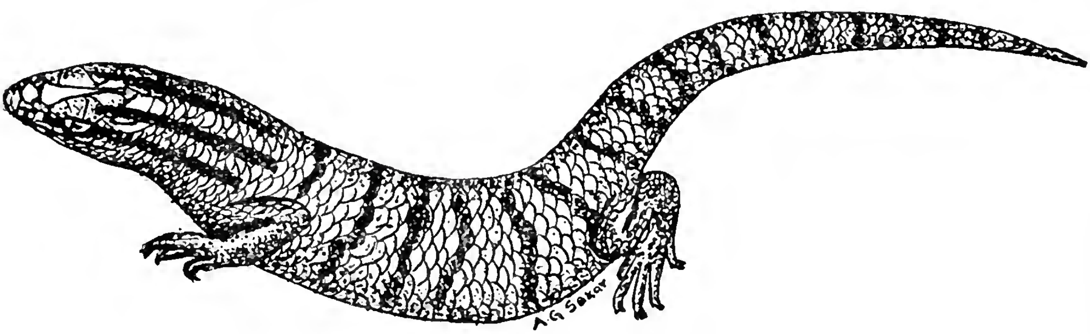

Fig. 1. *Dasia haliana* (H. Nevill)

reported from the southern-most part of the Western Ghats of Tamil Nadu, India.

The specimen measured 86 mm in snout to vent length with a 92 mm tail.

JUSTUS JOSHUA

MUNDANTHURAI WILDLIFE
SANCTUARY,
PABANASAM (VIA),
AMBASAMUDRAM TALUK,
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24. A NOTE ON GREEN WHIP SNAKE PREDATING ON *PHYLLOSCOPUS* SP.

On 10th of October 1984 I heard the distress call of a small bird at 14.40 hrs and as the pitch of the distress call increased I stepped out of my house and saw a small bird in the jaws of a Green Whip Snake *Ahaetulla nasutus* approximately 4 ft. in length coiled up on a *Wodina odiar* tree at a height of *c* 12 ft. The head and fore body on one of the branches of the tree with the rest of the body hanging downwards. The snake had caught what appeared to be a *Phylloscopus* spp., from its plumage and a stripe above the eye on the right shoulder. When I saw the snake, the bird was struggling to escape, but in vain and finally the bird stopped its calling.

After a lapse of about 15 minutes the snake began to swallow the bird by changing its 'catch position' slowly towards the neck of the bird. The head was taken in first and, the buccal cavity of the snake looked like a small pouch, I was surprised when the swallowed portion of the bird was brought out again and I wondered if the bird would be dropped but it was not. The bird was held by the neck and the process of swallowing started again with the 'head first' position. This time the process was very slow but did not stop till the entire bird was swallowed. I watched the prey moving in the throat of the snake, which raised its head and by movements of its anterior body the bird was apparently pushed down to almost the middle of the intestine. The snake

started moving away from its original position around 14.43 hrs. I was curious to see the state of the prey after it had been swallowed and caught the snake. On dissection the swallowed bird was seen to be quite intact with the legs and head placed in such a position giving the whole a spindle shape. There were also remnants of food in the viscera, in the form of feather and undigested remnants of a small bird. The snake is preserved in the Museum at the Society's field station at Point Calimere.

AVIFAUNA PROJECT,
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December 30, 1984.

R. PANNEERSELVAM
S. ALAGAR RAJAN

25. YOUNG COMMON SANDBOA (*ERYX CONICUS* SCHNEIDER) SWALLOWING BARRED WOLFSNAKE (*LYCODON STRIATUS* SHAW) DOUBLE ITS LENGTH

I am collecting snakes from urban areas from the point of conservation and research work. On the morning of eleventh May, I received a call from a resident of Bhavnagar City about a snake seen in his garden. I collected it, a young common sandboa (*Eryx conicus*) and bagged it in a cotton bag. While returning, I saw a wolfsnake by the side of the road. As I did not have another bag, I kept both snakes together.

On reaching home, I found that the sandboa had swallowed the wolfsnake upto half of its body length. The wolfsnake was almost double the length of the sandboa.

11, DESAI NAGAR,
BHAVNAGAR PARA,
BHAVNAGAR 364 003,
May 11, 1984.

RAJU VYAS

26. ON THE TAXONOMIC STATUS OF *APUS KASHMIRIENSIS* DAS (CRUSTACEA: BRANCHIOPODA: NOTOSTRACA: APODIDAE)

INTRODUCTION

The palaearctic tadpole shrimp of Kashmir — *Triops cancriformis* (Bosc) — has had a remarkably chequered history. The earliest reference to the occurrence of *Triops* in Kashmir is by Lawrence (1895) who, in his celebrated report on the valley of Kashmir, stated that "among the vegetable pests may be mentioned snails (*hangi*), leeches (*drik*) and a fish-like insect known as *Dadu*. These cause injury to the rice-plant". He also mentioned that "the cultivator also has to be on the lookout for snails and for *Dadu*, a fish-like insect with hard scaly wings, both of which eat up the young rice plants. When the rice plant is a foot high, the *Dadu* does no harm and is said to be of use, as it works the soil around the roots ....". It may be pointed out that even now *Triops* is called *Dadu* in

Kashmiri language and constitutes a fairly serious pest in the early stages of rice cultivation. It is evident that Lawrence's fish-like insect with hard scaly wings is none other than the Branchiopod *Triops*, whose hard shield-like carapace Lawrence mistook for wings.

Kemp (1911) described the specimens of *Triops* collected from Kashmir Valley by Major Walton and assigned these to the species *T. cancriformis*. He also collected specimens of this species from Banihal area (south of Pir Panjal range) at an altitude of about 8000 ft. and remarked that there are noticeable distinctions between the specimens obtained from Kashmir and those collected from the plains of India, but these are probably due to differences in biological conditions correlated with high altitude.

Tiwari (1951) gave an account of the Indian species of *Triops* and erected two new species (*Apus orientalis* and *A. mayliensis*). He also listed *Triops cancriformis* as being found in Kashmir in addition to such localities as Buland Shahr, Sargodha district, Punjab and Gujarat.

Hora *et al.* (1955) gave a brief account of some interesting features of the aquatic fauna of Kashmir Valley and stated that *Triops cancriformis* is very abundant in the rice-fields of Kashmir Valley as well as in the Dal Lake. The latest contribution by Das (1966) on the palaearctic elements in the fauna of Kashmir lists *Triops* (= *Apus*) *longicaudatus* as being found in Kashmir. In a subsequent contribution he (Das 1970) erected a new species for the Kashmir specimens of *Triops* and named it *Apus kashmiriensis*.

Distribution: In India *Triops cancriformis* (Bosc) has been recorded from Buland Shahr (Kemp 1911, Walton 1911), Nuriwalla, Sargodha district, Punjab (Bond 1934), Gujarat (Mahabale 1939) and Kashmir (Kemp 1911, Tiwari 1951, Hora *et al.* 1955). I collected specimens of this species from the Dal Lake and rice-fields at Sopore and Handwara (Kashmir Valley) as well as Poonch Valley (Jammu Province) (Nath 1979).

Discussion

The palaearctic branchiopod — *Triops cancriformis* (Bosc) — shows an erratic distribution, being found in several widely separated localities such as Kashmir, Uttar Pradesh (India), England, Italy, W. Germany, and Europe. It is certain that this branchiopod reached Kashmir along with several other palaearctic animals long before the geographical barriers between the palaearctic region and the rest of India were formed. Exceptionally well-preserved specimens of *Triops cancriformis* (Bosc) have been recovered from the Frankish Keuper (Upper Triassic), indicating that this species of *Triops* has survived unchanged for the last 200 million years, facing everything in the "asylum" of short-term water spates and long periods of dormancy within the egg, buried in dry mud. It is not surprising, therefore, that, in spite of its isolated existence in Kashmir from prehistoric times, *Triops* has not evolved into a new species. This offers a sharp contrast to the fate of several other palaearctic elements in the aquatic fauna of Kashmir (Das 1966) which, due to prolonged isolation and evolution under mountain-terrain conditions, have evolved into new species (e.g. *Schizothorax, Noemacheilus, Glyptothorax*, etc.).

Kemp (1911), Tiwari (1951) and Hora *et al.* (1955) studied the specimens of *Triops* collected from Kashmir and assigned these to the species *Apus cancriformis* Sch. Longhurst (1955) revised the Notostraca and reassessed the validity of a number of taxonomic charac-

ters. He also reduced the number of species of *Triops* (= *Apus*) to four.

I collected about 500 specimens of *Triops* from Dal Lake and adjacent canals and rice-fields at Sopore and Handwara (Kashmir) as well as from Poonch Valley (J. & K. State). Detailed study of these specimens has revealed that all of them belong to the species *Triops cancriformis* (Bosc).

Das (1970) studied the specimens of *Triops* collected from the Dal Lake and adjacent areas and erected a new species for them which he named *Apus kashmiriensis* on the basis of the following characters:

1 Size of the carapace;
2. Length of caudal styles;
3. Size of shell gland;
4. Number of abdominal segments;
5. Size of antennules and
6. Absence of antennae.

Das (op. cit.) further stated that his specimens differed from *Triops cancriformis* (Bosc) in:

a) The possession of a larger and stouter carapace;
b) The presence of a shorter second endite of the thoracic foot and
c) The length of the fourth endite which reaches far beyond the abdomen.

A large number of specimens of *Triops cancriformis* (Bosc) were obtained from Dal Lake and adjacent areas and compared with the specimens of *Triops* obtained from other localities in the State. As pointed out by Tiwari (1951) the important taxonomic characters for the identification of various species of *Triops* are:

a) The shape of the nuchal organ, and
b) The number of apodal segments.

As all the specimens of *Triops* collected from Kashmir and Poonch agree with *Triops cancriformis* (Bosc) in the shape of the nuchal organ (oval) and the number of apodal segments (6-8), I regard *Apus kashmiriensis* Das and *Triops cancriformis* (Bosc) as conspecific, and have assigned all specimens of *Triops* collected from Poonch Valley and Kashmir Valley to the latter species. The differences between *Triops cancriformis* (Bosc) and *Apus kashmiriensis* Das are non-taxonomic and probably due to the differences in biological conditions correlated with high altitudes. Thus there are insufficient grounds for the erection of a new species for the Kashmir specimens of *Triops*.

Moreover, according to the ruling given by the International Commission on Zoological Nomenclature in Opinion 502 (1958) the correct valid name for the branchiopod genus previously known as *Apus* Schaeffer, 1756, is *Triops* Schrank, 1803. Therefore Schaeffer's name *Apus* has been declared invalid as a pre-Linnaean usage and the generic name *Apus* Scopoli 1777 is the valid name for an avian genus of swifts (Tiwari 1972).

Acknowledgements

I am thankful to Dr. G. A. Boxshall of the Department of Zoology, British Museum of Natural History, London, for confirming the identification of the specimens under report. Thanks are also due to Dr. K. K. Tiwari, Director, Zoological Survey of India, Calcutta, for his valuable opinion.

SYSTEMATICS

Triops cancriformis (Bosc)

1911	*Apus cancriformis*, Kemp,	*Rec. Indian Mus., 6*: 353-357
1925	*Apus cancriformis*, Gurney,	*Ibid., 27*: 439-440
1931	*Apus cancriformis*, Barnard,	*Ann. S. Afr. Mus., 29*: 241
1934	*Apus cancriformis*, Bond,	*Mem. Connecticut Acad. Sci., 10*: 55, fig. 16
1951	*Apus cancriformis*, Tiwari,	*Rec. Indian Mus., 49*: 203
1955	*Triops cancriformis*, Longhurst,	*Bull. Brit. Mus. (N.H.), 3*(1): 1-57
1964	*Triops longicaudatus*, Das *et al.*,	*Kashmir Sci., 1*(1-2): 100-111
1970	*Apus kashmiriensis*, Das,	*Ichthyologica, 10*:5-7
1979	*Triops cancriformis*, Nath,	*J. Bombay Nat. Hist. Soc., 76*(3): 543-544.

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27. NEW RECORD OF LONG-HORNED GRASS-HOPPER, *HOLOCHLORA INDICA* KIRBY ATTACK ON PEACH AT RAIAN (PUNJAB, INDIA)

Long-horned grass-hopper, *Holochlora indica* Kirby, was found severely infesting a four year old orchard of peach (*Prunus persica* Batsch) at village Raian of District Ludhiana (Punjab) during March-May, 1981. Out of 300 peach trees, seventy five per cent were attacked by this pest. The damage was confined only to this orchard as the survey in the adjoining orchards did not reveal its presence. Crops like wheat and *berseem, Trifolium alexandrium* Linn. were harvested during April from the nearby fields.

The attack by adults of this grass-hopper was first noticed along the boundary of the orchard during the last week of March. They started feeding on leaves especially on the eastern side (Sunny side) of the tree Canopy. The affected portion appeared as 'burnt up' due to the feeding injury, often confused with sun affectation of the tender shoots. During April-May, the adults began to feed on developing fruits. At times the entire fruit was eaten up, leaving behind the stone that remained attached to the branch by the pedicel. The partially attacked fruits did not grow further and became deformed and thus proved to be complete loss to the fruit grower. Estimates based on the samples drawn from a hundred randomly selected trees, revealed that the infestation on the fruits ranged from 22 to 96 per cent with an average loss of 52 per cent. As a result of severe damage by *Holochlora indica*, the fruits could not be sold in the market, thus the grower had to suffer considerable financial loss.

The incidence of *Holochlora indica* Kirby thus seems to be the first record as a sporadic serious pest of peach tree in India. It may be taken as potential threat on early maturing peach fruits that are being grown in the north-western region of India.

We thank peach growers of Raian village, for providing facilities and field assistance. Sincere thanks are also due to the Director, Commonwealth Institute of Entomology, London for the identification of the pest.

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28. INFESTATION OF *SOLANUM INDICUM* LINNAEUS BY *DACUS (BACTROCERA) DORSALIS* HENDEL

During a recent survey of fruit fly fauna in Eastern India, heavy infestation of a fruit fly species was observed on *Solanum indicum* fruits. The infested fruits were brought to the laboratory and flies reared. The flies which emerged were identified as *Dacus (Bactrocera) dorsalis*. The female fly was also observed laying eggs in semiripe fruits of *S. indicum.* The number of eggs and larvae was found to be only 1 to 3 in each fruit. The larvae were observed feeding and growing in the pulpy material of the host fruits leaving the hard

seeds undamaged. A single larva was found to be enough to destroy a fruit completely. The infestation was so heavy that nearly 75 per cent fruits observed were infested.

S. indicum is a new host record of *D.* (*B.*) *dorsalis.* It is interesting to note *D.* (*B.*) *dorsalis,* a serious pest of a large number of fruits infesting a weed plant *S. indicum* (a common weed in waste grounds) and controlling its spread biologically.

Thanks are due to Dr. Harsh Kumar, Assistant Professor of Genetics, Rajendra Agricultural University, Bihar, Pusa (Samastipur) for identificaiton of weed plant.

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29. SOME OBSERVATIONS ON THE BIOLOGY OF MINT DEFOLIATOR *SCOPULA REMOTATA* GUENEE (GEOMETRIDAE: LEPIDOPTERA)

(*With a plate*)

Scopula remotata Guenee has been reported from India and has been described by several authors (Hampson 1895, Prout 1913, 1938). However, nothing is so far known about the host plants and the biology of this species. Some notes on the outlines of the Biology have been published in respect of *Scopula cleoraria* (Walker) (Sevastopulo 1943) and a few other geometrid species (Sevastopulo 1942, 1943, 1945, 1947). The present communication records some observations on the biology of *Scopula remotata,* procured from the mint runners in the Pharmaceutical Garden, Punjab University, Chandigarh.

Scopula remotata Guenee is a small-sized, creamish geometrid moth attacking the mint (Podina) plants (Plate I, 1) in North-West India, from middle of April to Middle of November during which period it passes about six generations. The adults live for 5-7 days and only occasionally consume a drop of water or sap from the injured parts of the host plants. The caterpillars are voracious eaters and defoliate the plants, reducing them merely to twigs (Plate I, 2).In such a condition, it becomes difficult to differentiate the caterpillars as they have a curious habit of holding the branches of the plants with the help of their last pair of prolegs and keeping the body stretched in a motionless posture (Plate I, 4), as also observed by Sevastopulo (1943) for *Scopula cleoraria.* The caterpillars also show cannibalistic tendencies, specially during the shortage of plant foliage. The male moths have ciliated antennae, short and dilated hind tibiae, narrow abdomen and a single spine-like frenulum in contrast to the serrate antennae, slender tibiae with two pairs of spurs each, swollen abdomen and the frenulum consisting of numerous bristles in the female.

LIFE CYCLE: The adults copulate soon after their emergence. The oviposition starts 24-30 hrs. after copulation. The eggs are laid singly but some of the eggs stick to each other forming small groups on the leaves. A female lays a total of about 70-85 eggs during its life span. Freshly laid eggs are light green and somewhat oval. The egg surface is divided into prominent squarish areas (Plate I, 3). After one day, the colour of the eggs turns to white and then gradually from light yellow through red to brownish-black before hatching. The embryonic stage lasts for 60-72 hrs. At the time of hatching, the caterpillar makes a circular hole in the egg shell at the narrow end or close to it. The portion of the egg shell cut off by the caterpillar is frequently consumed as the first meal. The larva takes an average of 14 seconds to make the exit hole and hatches out within about 2 minutes. The freshly hatched larva is very active and starts feeding on tender leaves of mint plants. The larva is fuscous dorsally and light yellow laterally and ventrally, with the latter surface carrying prominent black spots. It is about 2 mm long. The larva moults six times within a period of 18-21 days when the atmospheric temperature ranges from 29°C-32°C.

The fully grown larva measures about 20-22 mm in length. It stops feeding and becomes motionless. After 5-10 hrs., contraction of the larval body begins, reducing its length to 14-16 mm (Plate I, 5). At this stage the larva starts spinning the cocoon around itself. The site of cocoon formation varies a great deal in different circumstances. The cocoon can be prepared between two leaves, within a single rolled leaf (Plate I, 7) or by entangling sand particles and beads of faecal matter amongst silken threads (Plate I, 6). The preparation of the cocoon, irrespective of the mode of its formation, is completed within about 1 hr. and 40 minutes. After the completion of cocoon, the length of the caterpillar is further reduced to about 8-9 mm, marking the onset of prepupa stage. The prepupa moults into pupa within $3\frac{1}{2}$-4 minutes (Plate I, 8). The freshly formed pupa is glossy and light green. The pupal stage lasts for 5-7 days after which the adult moth emerges out. The total life cycle is completed in an average period of 28 days.

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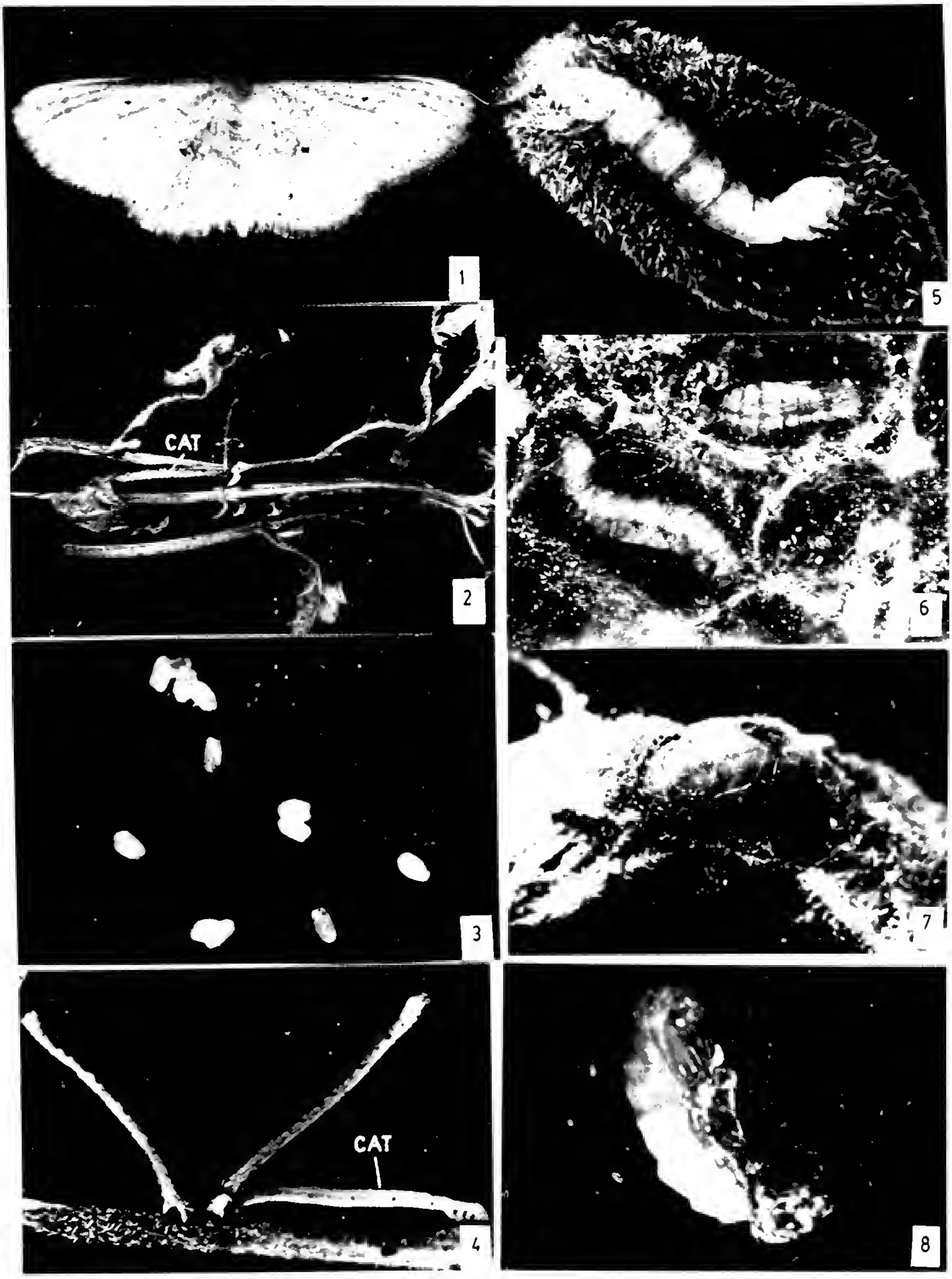
Walia & Pajni : *Scopula remotata*



See text.

Abbreviation : CAT — Caterpillar.

30. OCCURRENCE OF FLEA BEETLES, *CHAETOCNEMA* SPP. (COLEOPTERA: CHRYSOMELIDAE) ON *FIRMIANA COLORATA*

Firmiana colorata is a moderate sized ornamental tree. It produces orange scarlet flowers borne in long pendulous clusters. During the period of July to August, 1984, two year old *F. colorata* plants were found to be infested by three species of flea beetles: (Coleoptera: Chrysomelidae) namely: *Chaetocnema basalis* Baly, *C. concinnipennis* Baly and *C. indica* Weise on Agricultural College Campus, University of Agricultural Sciences, Dharwad, Karnataka.

Joshi *et al.* (1969) recorded *C. basalis* as a serious pest of wheat in Rajasthan. Similarly, *C. concinnipennis* caused severe damage to newly transplanted seedlings of rice at Cuttack (Kulshreshtha and Mishra 1970). Reddy *et al.* (1980) observed *C. basalis* and *C. indica* damaging an ornamental hedge plant, *Alternanthera* sp. at Dharwad in Karnataka.

The adults of all the three species scraped the leaf lamina on the dorsal surface in irregular fashion and the damaged leaf presented characteristic scrape markings which turned brownish later. Severely injured leaves dried and dropped down. The number of beetles ranged from 1 to 13 per leaf. The beetles hid on the ventral surface of leaves during the sunny hours of the day. The species were observed in large numbers in mating pairs on the leaf surface. They used to fall to the ground at the slightest disturbance. The present report of *C. basalis*, *C. concinnipennis* and *C. indica* on *F. colorata* appears to be the first of its kind.

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31. TWO NEW RECORDS OF CYPERACEAE FROM UPPER GANGETIC PLAIN

(*With two text-figures*)

INTRODUCTION

During floristic exploration of Basti District (U.P.), one of us (DCS) collected two interesting cyperaceous species which were subsequently identified and confirmed as *Fimbristylis argentea* Vahl and *Scirpus setaceus* L. The former, although said to be a species of

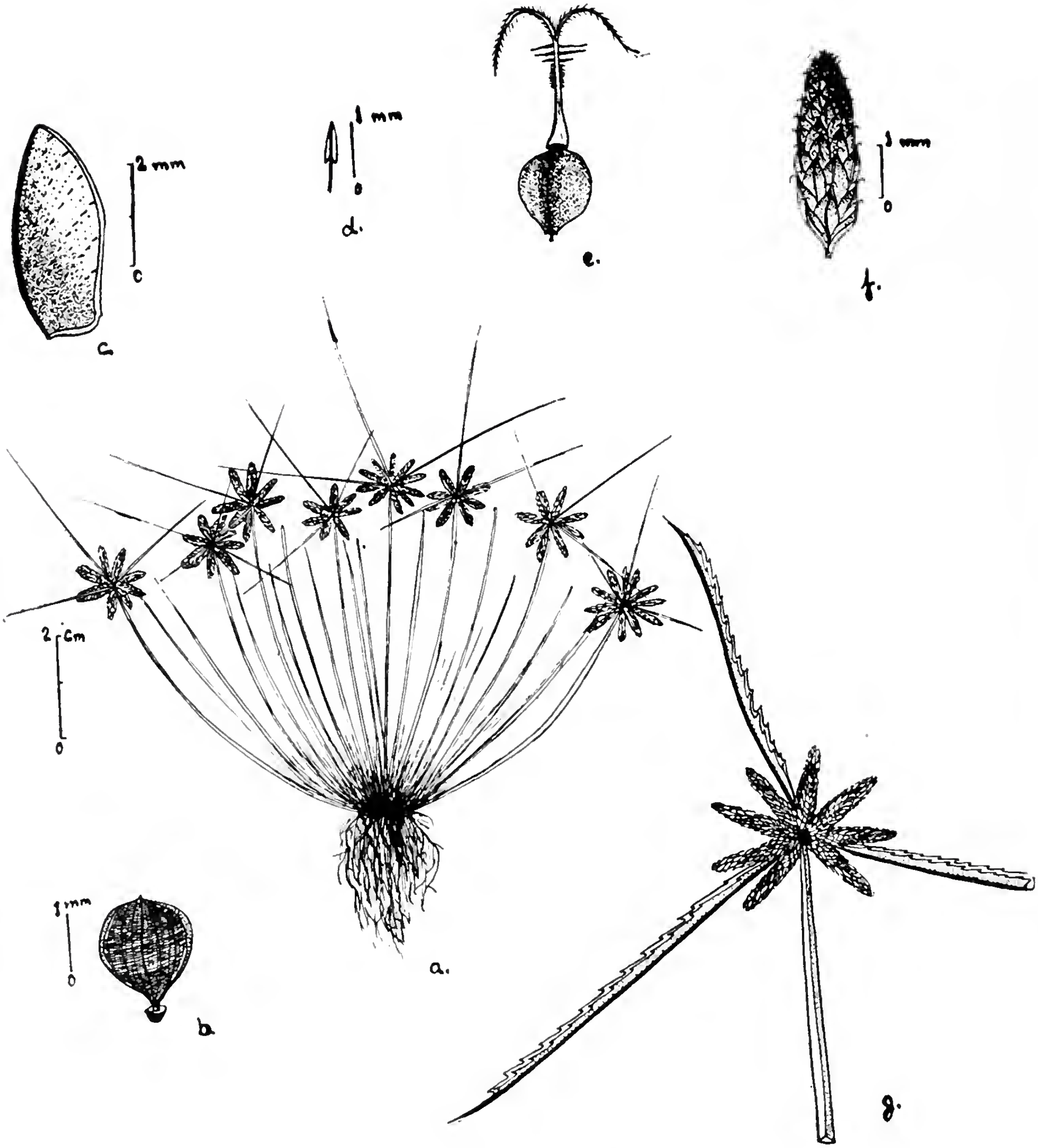

Fig. 1. *Fimbristylis argentea* Vahl.
a. Habit of the plant; b. Nut; c. Glume; d. Stamen; e. Nut with style and stigma, f. Spike; g. Inflorescence.

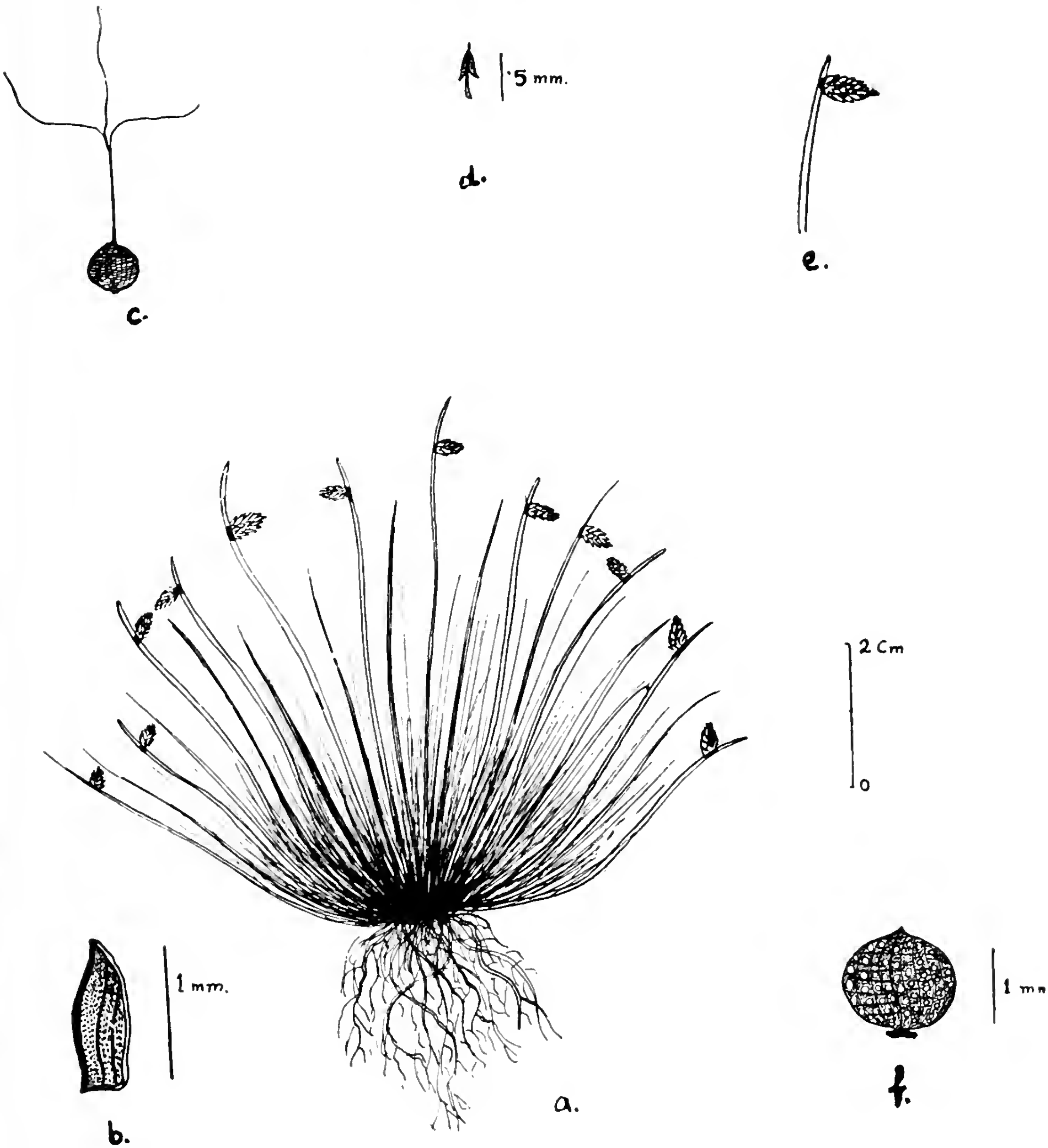

Fig. 2. *Scirpus setaceus* Linn.
a. Habit of the plant; b. Glume; c. Nut with style and stigma; d. Stamen; e. Spike; f. Nut.

Tropical Africa, has been distributed throughout Bengal, Bihar and Central India. (Hooker 1893, Haines 1961, Prain 1963). The latter is a temperate species occurring at high altitudes in Himalayan forests from Sikkim to Kashmir (Hooker 1893, Singh & Kachroo 1976). But these are not recorded from the region of Upper Gangetic Plain by earlier workers Duthie 1903-1929, Raizada 1976, Rau 1969, Singh 1979, Vishwanathan *et al.* 1984). Occurrence of both tropical and temperate species close to Nepal territory within the geographical limits 20°30′ and 27°30′ N and 82°12′ and 83°53′ E, is a new record and may be of interest from the phytogeographical, ecological and taxonomic view point.

Fimbristylis argentea (Rottb.) Vahl. Enum, Pl. 2: 294. 1805; Clarke, Fl. Brit. India 6: 640, *Scirpus argenteus* Rottb. Programme. 27, 1772.

A caespitose annual sedge upto 20 cm. height. Roots fibrous. Stem slender, trigonous. Leaves filiform, glabrous, shorter than the stem; sheath short, glabrous, reddish brown. Inflorescence terminal, with 4-20 spikelets, aggregated on the apex of culms. Bracts 2-4, 3-5 cm. long. Glume 0.6-8.8 x 0.4-5 mm., ovate, acute or shortly mucronate, glabrous, membraneous with red spots. Stamen 1; Style 2-4 mm. long, glabrous, slightly hairy below the bifurcation. Stigma nearly as long as the style, bifid, hairy. Nut 4 mm. long, obovoid, biconvex, white with 7 longitudinal striations (on both surfaces), slightly margined, apex pointed, base with minute gynophore.

Flowers and Fruits: August-December; Saini, 4848.

Locality & Field Note: The specimens were collected from paddy fields near the village of Bansi in the district of Basti, chiefly associated with *Aeschynomene indica* Linn., *Alternanthera sessilis* (Linn.) DC., *Cyperus rotundus* Linn., *C. alulatus* Kern., *Phyla nodiflora* (Linn.) Greene, *Paspalum scrobiculatum* Linn. and *Echinochloa colonum* (Linn.) Link.

Scirpus setaceus Linn. Sp. Pl. 49. 1753; C. B. Cl. in Fl. Brit. India, 6: 654, 1893.

A caespitose, small, glabrous, annual sedge up to 7 cm. high with brown, fibrous roots. Stem filiform, weak. Leaves about 2 cm. long, setaceous, sometimes nearly as long as the stem, glabrous; sheath short, glabrous, straw coloured. Spikelets pseudolateral, single on each stem. 2-3 x 1.2-1.5 mm., chestnut coloured with 6-20 flowers, bract as through the continuation of stem, about 6 mm. long. Glumes 0.7-1.0 x 0.5-0.7 mm., glabrous, ovate, keel green with 3 prominent nerves, sides dark reddish with two nerves. Bristles none. Stamens 3, filament short; anther apiculate, style short; stigma 3, filiform, longer than the style. Nut brown, 0.6-1.0 mm, long obovoid, trigonous, apiculate, 9 longitudinal striations on each surface, transversely trabeculated between the striations.

Flowering & Fruiting: October-March.

D. C. Saini, 5909.

Locality & Field Note: I (D.C.S.) collected only one colony of the plant along Banganga River in association with *Bacopa monnieri* Linn., *Cyperus difformis* Linn., *Dentella repens* Forst. and *Phyla nodiflora* (Linn.) Greene.

The collected specimens have been deposited to the Herbarium, Botany Department, Gorakhpur University, Gorakhpur.

ACKNOWLEDGEMENT

We thank Prof. E. Govindarajalu, Head, Botany Department, Presidency College, Madras for confirming the identity of specimens.

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32. FAMILY CERATOPHYLLACEAE IN THE KASHMIR HIMALAYAS

In our area the family is represented by a single species, *Ceratophyllum demersum* L., which is a winter dormant, forming compact terminal buds giving new plants in the spring.

Ceratophyllum L. Sp. Pl. 992 (1753)

Submerged, perennial, olive green herbs, with articulate fragile stems. Leaves whorled, 1-4 times divided into filiform segments. Flowers solitary in the axils of the leaves; male flowers with 10-20 stamens: perianths oblong, 2-3 toothed, white; pistillate flowers with green perianth. Fruit headed by the slender persistent style.

Ceratophyllum demersum L. Sp. Pl. 992 (1753). Hook f. Fl. Brit. Ind. 5: 639 (1888). Subramanyam, Aq. Angios. 52 (1962). Aziz, Fl. Pak. 70 (1-3) 1974.

Much branched rootless perennial herbs can be easily recognised in the field in having leaves in whorls of 4-10, forked once or twice into 2-4, filiform linear dark green segments, segments acute, finely serrate. Flowers small, axillary, monoecious sessile, solitary in the axils of leaves; perianth rarely present herbaceous; stamens 10-18 on a flat torus, anthers coloured; ovary sessile, unilocular with a solitary ovule. Fruit an achene, oblong 2-6 x 2 mm with 3 spines; upper spine double the size of fruit, 2 basal spines almost equal to fruit. Pollen grains acolpate (non-aperturate) spheroidal 26.0 x 26.0 μ, exine very thin, undifferentiated into sexine and nexine; intine thin, psilate; stratification obscure. The genus seems to be unique among the hydrophytes bearing psilate pollen grains showing close resemblance with the family Callitrichaceae.

Abundant in the lakes, ponds, streams and in the rice fields Harwan, A. M. Kak 3717:

Shalimar, A. M. Kak 3620; Leper Hospital (Nagin lake) A. M. Kak 3567; Dialgam (Anantanag) A. M. Kak 3429; Sd, 251; *Distribution*: Caucasus; Europe, Siberia, Central Asia, Kashmir (India), Pakistan.

Occasionally the seeds and foliage provide food for wild fowl. The dense vegetative growth provide shelter for fish and other aquatic animals. Also as a room for insects that are valuable as a fish food. The young seedlings are grown in aquaria for decoration. The leaves are used as purgative, diuretics and remedies for biliousness and jaundice. Sometimes the extract from plants are mixed with oil or mucilagenous base and applied externally to treat elephantiasis. In Kashmir it is mainly used in the preparation of floating islands, also used as manure along with other aquatic plants.

ACKNOWLEDGEMENTS

We are thankful to Dr. J. N. Javeid, for going through the manuscript and one of us (AMK) is also grateful to the Principal, Sarwar Hussain and Hussain Ahmad, Head, Botany department for providing laboratory facilities.

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33. SEASONAL VARIATIONS IN THE PEAKS OF PHYTOPLANKTON IN LAKHOTIA LAKE

(*With a text-figure*)

The chlorophyll bearing, microscopic plant plankton, the phytoplankton, form a basic component of an aquatic ecosystem as they are the main primary producers. The seasonal variations of phytoplankton depend on the supply of nutrients in the ecosystem. The supply of nutrients is governed by the catchment area and the source from which the freshwater bodies receive the water. Most of the literature both on south as well as on north Indian freshwaters is concentrated only on the relation of phytoplankton and nutrients. In the present study, therefore, an attempt was made to observe the seasonal variations in the peaks of phytoplankton during hydro-biological studies of Lakhotia Lake, located at Pali.

Pali district comes in the western region of Rajasthan. The climate of this region is characterised by extremes of temperature and aridity. Owing to the dryness of the atmosphere, nature of soil and lack of thick vegetation, the annual variations of temperature are very high. Following seasons have been reported in the study area.

Summer: March-June; Monsoon: July-October; Winter: November-February.

Lakhotia is on the north side at the foot of (25.8°N Lat. and 73.3°E Long.) Pali city. It

TABLE 1

SEASONAL VARIATIONS OF NUTRIENTS AND PHYTOPLANKTON IN LAKHOTIA LAKE

Parameter	Depth	Season		
		Summer	Monsoon	Winter
Silica	Surface	0.445– 3.512	1.010– 5.251	2.125– 4.501
mg. Sio^{2}_{2}/lit.	1m	0.185– 3.751	1.875– 5.251	2.501– 4.501
	Bottom	0.301– 3.952	1.875– 5.251	2.875– 4.750
Phosphate	Surface	0.60 – 1.5	0.21 – 1.95	0.450– 0.9
ug. at./lit.	1m	0.60 – 1.35	0.15 – 2.85	0.600– 1.2
	Bottom	0.675– 2.85	0.21 – 3.15	0.625– 1.5
Nitrate	Surface	10.2 – 31.5	3.0 – 12.0	1.5 – 9.0
ug. at./lit.	1m	12.2 – 36.0	2.25 – 15.0	1.5 – 9.0
	Bottom	13.5 – 39.0	3.0 – 22.5	3.0 – 10.5
Phytoplankton	Surface	136 –338	125 –268	148 –340
Units x 10^3/lit.	1m	142 –379	145 –242	124 –354
	Bottom	150 –358	136 –270	130 –376

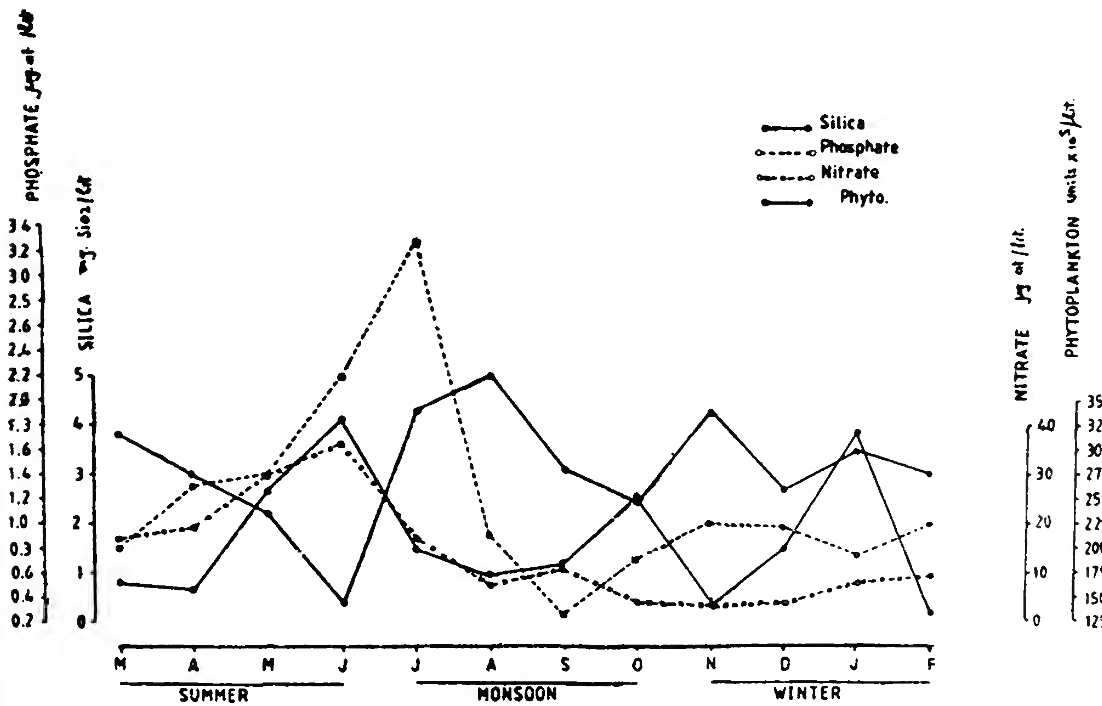

Fig. 1. Seasonal variations of phytoplankton and nutrients in Lakhotia lake.

is a man-made, rain-fed, perennial lake roughly triangular in shape having a maximum length of 1825 m in the east-west direction and a breadth of 950 m in the north-south direction with a maximum depth of 4.5 m during the study period. It's northern limits are marked by the boundary wall of Umaid Textile Mills premises while the southern border is encircled by a series of Pucca ghats. On the eastern bank are Dharamsalas and temples and the western side has a spillway. For more details see Khatri (1983).

For the assessment of nutrients and phytoplankton along horizontal as well as vertical profile of Lakhotia lake three stations (st. 1, 2 and 3) and three depths (surface, 1 m and bottom) were selected. Samples were collected at monthly intervals for a period of twelve months (March, 1977 — through February, 1978). 500 ml of water from surface and subsurfaces for the detection of nutrients were collected. Silica was estimated after Jhingran *et al.* (1969). Phosphate was determined by stannous chloride reduction method (Murphy and Riley 1962) and nitrate as per Mullin and Riley (1955). Phytoplanktons were counted by sedimentation method after fixing 500 ml samples in Lugol's Iodine solution and preserving in 3% formaldehyde solution. Identification was done up to generic level results were expressed in units/lit. (Table 1)

The phytoplankton population comprised of the members of chlorophyceae, cyanophyceae, bacillariophyceae and dinophyceae. Three peaks of phytoplankton were observed one each in summer, monsoon and winter seasons (Fig. 1). The first peak was recorded in June but in the following month the population of phytoplankton sharply declined due to dilution caused by rain and water coming from an adjacent Lhoria Tank into the lake. The concentration of nutrients increased first being washed out along with the inflowing water. The overflow of the spillway carrying a bulk of phytoplankton disturbed the ecosystem in the lake. There was also decrease in nutrient level but not to the extent of phytoplankton. Hence, to re-establish the disturbed ecosystem a quick cycling of phytoplankton took place resulting in the second peak in monsoon season (October) and third in winter season (February).

In the other lakes of western Rajasthan, Bohra (1976) observed two peaks each in Padamsagar (monsoon and winter), Ranisagar (summer and winter) and Misra *et al.* (1978) reported only one peak in the monsoon season in lake Balsamand. Although, Bohra (1976) observed overflow of banks in Padamsagar and Ranisagar during monsoon yet there was no decrease in phytoplankton. The above authors viewed these differences with the developmental stages of the lakes. It is apparent that the established eutrophic lakes have only one peak as in the case of Balsamand while comparatively less developed lakes (Padamsagar and Ranisagar) have two peaks of phytoplankton. The occurrence of three peaks in Lakhotia lake during the study period shows that the lake is still in an early stage of eutrophic condition as most of the characters are of oligotrophic level. The number of peaks of phytoplankton, hence, may be considered as a character along with others such as nutrient level, phytoplankton density and depth, to differentiate the oligotrophic lakes from eutrophic ones.

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JODHPUR, INDIA,
August 12, 1983.

T. C. KHATRI[1]

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[1] *Present address*: Zoological Survey of India, 36/802, Karakkamuri Cross Road, Cochin, India.

34. A NEW NAME FOR *ACACIA WIGHTII* BAKER EX BENTH.

A plant growing on the sea coast of Malabar was collected by R. Wight and was noted by Baker as *Acacia wightii*. One of these specimens is located at Calcutta herbarium and another at Kew herbarium. The species was described by Bentham and the authority was attributed to Baker. Hence the author citation should be as follows —

Acacia wightii Baker ex Benth. in Trans. Linn. Soc. 30: 506, 1875. and not *A. wightii* Baker in Hooker's Fl. Brit. India 2: 298, 1870 as is cited in most Indian Floristic works.

Wight 896, thus becomes lectotype of the species. There are two specimens — one deposited at CAL and other at KEW. It is proposed here to consider KEW specimen as lectotype and CAL specimen as isolectotype.

Graham collected a plant and listed it in Wallich's Catalogue under no. 5259 as *Acacia wightiana*. It is a nomen nudum and its description was provided by Wight and Arnott in Prodr. Fl. Ind. Or. 1: 274, 1834 under the name *Acacia wightii* and authority was attributed to Graham. Hence the citation should run as follows —

Acacia wightii Graham ex Wt. and Arn. Prodr. Fl. Ind. Or. 1: 274, 1834.

Graham's species is conspecific with *Albizzia amara* Boiv. in Trans. Linn. Soc. 30: 567, 1875 and subsequent researchers have followed him.

Thus *Acacia wightii* Baker ex Benth. (1875) is a later homonym of *Acacia wightii* Grah. ex Wt. and Arn. (1834) and must be rejected in accordance with Art. 64 of International code of Botanical Nomenclature.

At present there is no other name available for this plant. Hence it is proposed here to call this plant as *Acacia bolei* nom. nov. The specific epithet is given in honour of Prof. P.

V. Bole, Blatter Herbarium, St. Xavier's College, Bombay.

Its new name and its pertinent synonymy is as follows —

Acacia bolei nom. nov.

A. wightii Baker ex Benth. in Trans. Linn. Soc. 30: 567, 1875. (non Graham ex Wt. and Arn. 1834).

The type would be the type of *A. wightii* Baker ex Benth., i.e. Wight 896, lectotype at KEW and isolectotype at CAL. In accordance with Art. 7 of International Code of Botanical Nomenclature.

BLATTER HERBARIUM,
ST. XAVIER'S COLLEGE,
BOMBAY - 400 001.
August 25, 1983.

RAVINDRA P. SUBHEDAR

35. *HIBISCUS CALYPHYLLUS* CAV.: A NEW RECORD FOR ANDHRA PRADESH

Hibiscus calyphyllus Cav. Diss. 5 : 283. t. 140, 1787; Rakshit & Kundu in Bull. Bot. Surv. India 12 : 172. 1970. *Hibiscus cannascens* Heyne in Wall. Cat. 2698. 1828-49 (nom. nud.). Wt. & Arn. Prodr. 49. 1834; Masters in Fl. Brit. Ind. 1: 337. 1874; Gamble, Fl. Pres. Madras 1: 70. 1957 (repr. ed.). (MALVACEAE).

Shrubs 2-2.5 m tall. *Leaves* 4-12 cm x 3.5-9.5 cm, broadly ovate-cordate, palmately 7-nerved, hairy above, stellate-tomentose below, margins distantly toothed, entire or shallowly lobed, acute or acuminate at apex, petioles 1.5-12 cm long, stipules 0.8-1 cm long, linear, setaceous, caducous. *Flowers* solitary, large yellow with purple centre at base inside, epicalyx 5 segments, 1.5-2.5 cm long, longer than calyx, calyx trinerved, connate near middle, lobes ovate, acute or obtuse. *Capsules* in persistant calyx, 1.5-2.5 cm x 1-2 cm densely hairy, spinous-pointed. *Seeds* 5 mm long, cottony hairy.

Rare, but conspicuous on hill slopes in thick forest with its large purple centered yellow flowers. I noticed two or three plants in flowers and fruit.

Herbarium specimens examined: Udayagiri in Nellore district, Andhra Pradesh: *BS* 4314, 30.1.1972, *BS* 4745, 21.12.1973.

Distribution: Karnataka: Mysore; Tamil Nadu: Tinnevelly; Andhra Pradesh: Udayagiri in Nellore district (author's collection); Ceylon.

The identity of this plant is confirmed by the courtesy of Central National Herbarium, Howrah. The specimens are deposited at the Visvodaya Government College Herbarium, Venkatagiri Town in Andhra Pradesh and Madras Herbarium, BSI, Coimbatore.

This plant hitherto is known to occur in Western Peninsula only and its report now from Udayagiri in Nellore District is a new record for Andhra Pradesh from Eastern Peninsula.

ACKNOWLEDGEMENTS

I thank the Director, Botanical Survey of India for necessary information and help and Dr. M. Sanjappa, Systematic Botanist, BSI,

Howrah for his helpful suggestions. I am also grateful to the Principal, Jawahar Bharati, Kavali for facilities and to the UGC for financial assistance under COSIP.

B. SURYANARAYANA

HEAD OF THE DEPARTMENT OF BOTANY,
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VENKATAGIRI TOWN, A.P.,
October 21, 1983.

36. OCCURRENCE OF *ONYCHIUM FRAGILE* VERMA ET KHULLAR FROM KUMAON HIMALAYA

While exploring the flora of Kumaon Himalaya the senior author came across a specimen of *Onychium fragile* Verma et Khullar at Jageshwar in Almora district. This species has so far been reported only from Kashmir and Mussoorie, and is now being reported for the first time from this region.

Onychium fragile Verma et Khullar, Nova Hedwigia, 9, 85, 1965; Khullar & Sharma, Aspects of Plant Science (Ed.) III, 82, 1980. Dhir, Ferns of North-Western Himalaya, 35, 1980.

Plants small, fragile. Rhizome short, creeping, apex clothed in brown coloured lanceolate scales. Fronds small. Stipe straminuous black at base. Lamina 4-pinnate. Infertile apex of fertile segments mucronate. Inducial margins pale coloured. Ripe capsule brownish. Spores large, trilet with a broad equatorial girdle having reticulate ornamentation.

This species does not appear to be common in this area. Few plants were found growing under shade of Deodar forest.

Specimen examined: Kumaon Himalaya, District Almora, Jageshwar 1810 m, P. C. Pande 10363. The voucher specimen is deposited in the Herbarium of Department of Botany, Punjabi University, Patiala, India.

ACKNOWLEDGEMENT

P. C. Pande is grateful to the University Grants Commission, New Delhi, for financial assistance.

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S. S. BIR[1]

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ALMORA, U.P., INDIA,
January 16, 1984.

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37. INCIDENCE OF SEEDLING FORMATION IN *RHIZOPHORA LAMARCKII* MONTR. AT PICHAVARAM MANGROVE, TAMIL NADU, INDIA

Occurrence of *Rhizophora lamarckii* has already been reported from New Caledonia, Papua New Guinea and Queensland (Tomlinson and Womersley 1976) and also Pichavaram mangrove forest (Lakshmanan and Rajeswari Mahalingam 1983). Complete absence of seedlings in these plants in the Port Moresby area (New Guinea) has been reported (Tomlinson and Womersley 1976). This particular character of these plants and their

presence along with *R. apiculata* and *R. stylosa* has led to a suggestion that, possibly, *R. lamarckii* is a hybrid between *R. apiculata* and *R. stylosa.* Sterility of the female, possession of intermediate characters (between those of *R. apiculata* and *R. stylosa*) by the flowers of *R. lamarckii* and aberrations in stamen morphology were given as supporting evidence for the above suggestion. Formation of seed in these plants in New Caledonia and Occasional seedlings in Hinchinbrook population (Queensland) has however been indicated.

Rhizophora lamarckii in Pichavaram mangrove forest is a tall tree with a spreading canopy. It can be easily recognized by its height and broad and leathery leaves. It is intermingled with *R. apiculata* and another species resembling *R. stylosa* (this species has all the characters of *R. stylosa*, but has only short style). Seedlings are mostly absent in these trees. However a rare case of a seedling was observed from a *R. lamarckii* during one of our visits on 10.7.1983.

This viviparous seedling along with its parent twig, was collected and is preserved in the Herbarium CAS in Marine Biology, Annamalai University. An examination of this seedling suggests that the hypocotyl is broader than the hypocotyl of either *R. apiculata* or the other species resembling *R. stylosa.* Nothing is known about its viability as no other seedling could be observed in these trees during subsequent visits.

The very rare occurrence of seedling in these plants which are present in appreciable numbers suggest the need for genetic and embryological studies to know about their propagation.

CAS in Marine Biology,
Parangipettai 608 502,
January 30, 1984.

K. MUNIYANDI
R. NATARAJAN

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38. *OXYGONUM* BURCH. (POLYGONACEAE) — AN INTERESTING NEW RECORD FROM INDIA

(*With a text-figure*)

In the course of my studies of the Flora of Quilon Town, Kerala State, I collected a polygonaceous species which was identified by Kew authorities as *Oxygonum sinuatum* (Hochst. et Steud. ex Meisn.) Dammer. There is no record of the occurrence of any species of *Oxygonum* Burch. anywhere in India. Therefore the genus itself is an addition to Indian Flora.

The combined characters of (1) herbaceous habit, (2) terminal racemose inflorescence, (3) bisexual flowers, (4) gamophyllous nature of the perianth and (5) prickly fruit make this genus distinct from all other Indian polygonaceous genera.

Oxygonum sinuatum, diffuse scabrid herbs; branches upto a metre long, decumbent to procumbent; internodes terete, striate, and

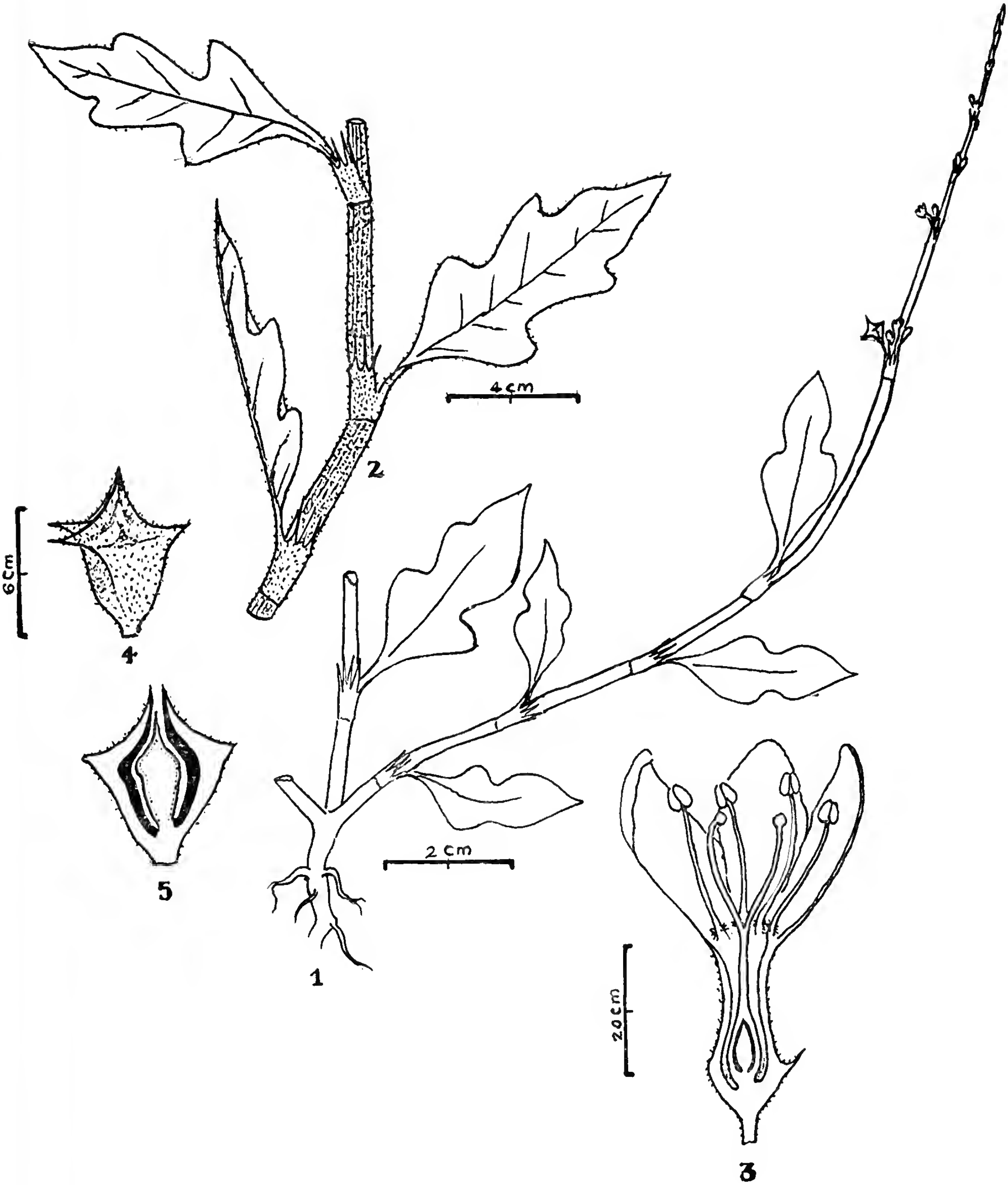

Fig. 1. *Oxygonum sinuatum* (Hochst. et Steud. ex Meisn.) Dammer.
1. Habit; 2. A portion of twig enlarged; 3. L. S. of flower; 4. Fruit; 5. L. S. of fruit.

scabrid. Leaves simple, alternate, ochreate, upto 4.5 cm. x 2 cm.; ochrea 0.5 to 0.7 mm. long, faintly striate, scabrid with a straight mouth carrying 8 to 9 slender, basally slightly hairy 5 mm. to 6 mm. long setae; blade elliptic-lanceolate in outline with undulate entire to pinnatifid margin, acute-mucronate at tip and cuneate at base tapering into a short petiole; veins 5-6, faintly impressed above and raised below; the margins and veins below scabrid, glabrous otherwise. Inflorescence terminal, elongate and racemose with one to a few flowers in the axils of ochreate bracts; peduncle triquetrous and scabrid on the margins. Flowers actinomorphic, bisexual, with a $\pm$ 3 mm. long slender pedicel scabrid on the margins. Perianth lobes 5, $\pm$ 4 mm. long, less than $\frac{1}{2}$-way basally connate; the gamophyllous portion greenish and scabrid outside, with 3 spinescent emergents at the base; the free lobes elliptic-lanceolate with acute to obtuse tip, quincuncial. mauve to white, the outer greenish and faintly scabrid along the back. Stamens 7-8, epiphyllous, arising from the mouth of the perianth tube, variable in length, inserted; filaments with a tuft of hairs at the base, just above the point of insertion, glabrous otherwise; anthers 2-celled with longitudinal dehiscence. Pistil small, $\pm$ 2.75 mm long, ovary elongate-lanceolate, about 0.75 mm. long with 3, $\pm$ 2 mm. long slender basally connate styles, each ending in a globular stigma; ovary 1-celled and 1-ovuled with a basal placentum. Fruit is an achene enclosed in a hard covering of the persisting basal portion of the perianth, the whole more or less top-shaped with 3 radiate sharp and hard prickles, conical base and apex and 8 mm. x 6 mm. including the prickes. Seed endospermous; embryo straight.

Ravi 1630 A, collected from Quilon, Kerala State on 2nd August, 1984 has been deposited in the Central National Herbarium, Calcutta (CAL), Ravi 1630 B, is deposited in the Regional Herbarium of the Southern Circle of B. S. I. (MH) and Ravi 1630 C-F, are deposited in the Sree Narayana College Herbarium, Quilon.

I first collected the plants from near a railway track in 1968. Since then the plant has spread to the neighbouring localities and now it is a menacing weed. *Oxygonum sinuatum* which is an Egyptian plant might have been introduced into the locality by accident through the railway. The hard and sharp prickles of the fruit help easy dispersal of the plant through the agency of grazing animals.

I am grateful to the Indian Liaison Officer at the Kew Gardens for his help in the identification of the taxon.

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August 24, 1984.

N. RAVI

39. ARTICLE 25 OF ICBN AND ITS APPLICATION IN NOMENCLATURAL CHANGES OF SOME INTRA-SPECIFIC TAXA FROM INDIA

The Article 25 of the International Code of Botanical Nomenclature states, "For nomenclatural purposes, a species or any taxon below the rank of species is regarded as the sum of its subordinate taxa, if any".

During the course of our studies on Indian

plants we have come across some names in taxonomic nomenclature which need correction as follows:

1. **Symplocos laurina** (Retz.) Wall. ex Rehd. & Wils. ssp. **cochinchinensis** (Lour.) comb. nov.

Basionym: *Drupatris cochinchinensis* Lour. Fl. Cochinchin. 314, 1790.

Recently, Ramamoorthy (in Saldanha & Nicolson, Fl. Hassan Dist. 198, 1976) has published a new combination *Symplocos cochinchinensis* (Lour.) Moore ssp. *laurina* (Retz.) Nooteboom apud Ramamoorthy, based on basionym *Myrtus laurina* Retz. (Obs. Bot. 4: 26, 1786). It is obvious from the nomenclature given and the note at the end by the editors that Nooteboom considers *Drupatris cochinchinensis* Lour. and *Myrtus laurina* Retz. distinct at sub-specific rank within a single species. However, the name *Myrtus laurina* Retz. is the earliest binomial available for the taxon at species rank and should be accepted and therefore *Drupatris cochinchinensis* Lour. should be treated as a subspecies of the former. Therefore, a new combination under genus *Symplocos* N. Jaquin is proposed.

2. **Marsilea ballardii** Gupta var. **rajasthanensis** (Gupta) comb. nov.

Basionym: *M. rajasthanensis* Gupta, in Botanical Monog. 2, (Marsilea) CSIR: 29, 1962.

Gupta (1955), described a new species of *Marsilea* from Ajmer and named it *Marsilea ballardii* Gupta (Journ. Bombay nat. Hist. Soc. 53: 289, 1955). Later in Botanical Monograph (l.c.), he described another species *Marsilea rajasthanensis* Gupta and reduced *M. ballardii* Gupta to a varietal rank to *M. rajasthanensis* Gupta, stating that it is only a distinct variety of *M. rajasthanensis* Gupta, with abnormal sporocarps.

According to the Article 25 of ICBN, if *M. ballardii* Gupta and *M. rajasthanensis* Gupta are to be considered as two distinct varieties of some species, then *M. ballardii* Gupta has the priority over *M. rajasthanensis* Gupta and should be accepted as the correct name at species level and consequently other variety will go as *Marsilea ballardi* Gupta var. *rajasthanensis* (Gupta) comb, nov., as proposed here. If the typical variety *ballardii* is the abnormal form or if it is only partly described, its specific description may be emended. But the specific name should not be changed from *M. ballardii* Gupta to *M. rajasthanensis* Gupta.

3. **Arthraxon microphyllus** (Trin.) Hochst. var. **hindustanicus** (Jain et Deshpande) comb. nov.

Basionym: *A. lancifolius* (Trin.) Hochst. var. *hindustanicus* Jain et Deshpande, Journ. Ind. Bot. Soc. 51: 176; 1972.

Jain and Deshpande (l.c.), described a new variety of *Arthraxon lancifolius* (Trin.) Hochst. as *A. lancifolius* (Trin.) Hochst. var. *hindustanicus* Jain et Deshpande. *Arthraxon microphyllus* (Trin.) Hochst. and *A. lancifolius* (Trin.) Hochst. have been based on *Andropogon microphyllus* Trin. and *Andropogon lancifolius* Trin. respectively and they were published and used in new combinations simultaniously by the same authors. However, Hackel (in DC. Monogr. 6: 35, 1889), is the first author who merged them in a single species under the name *Arthraxon microphyllus* (Trin.) Hochst. Therefore under Article 25 of ACBN *A. microphyllus* (Trin.) Hochst. is

accepted as the correct name for the species and a new combination *A. microphyllus* (Trin.) Hochst. var. *hindustanicus* (Jain et Deshpande) comb. nov. is proposed.

BLATTER HERBARIUM,
ST. XAVIER'S COLLEGE,
BOMBAY-400 001.

S. M. ALMEIDA

ALCHEMIE RESEARCH CENTRE,
THANE-400 601.
September 6, 1984.

M. R. ALMEIDA

40. ON THE OCCURRENCE OF *ACHYRANTHES ASPERA* L. VAR. *PUBESCENS* (MOQ.) TOWNS. IN THE TAMILNADU CARNATIC

(*With three text-figures*)

The two species *Achyranthes aspera* L. and *A. bidentata* Blume are easily recognized (Gamble 1925). However, three collections, RHT 1124 (Pennagaram), RHT 20544 (Denkanikotta) and RHT 24561 (Thally) from Dharmapuri District at the northwestern corner of the 'Tamilnadu Carnatic' bordering on Karnataka State, differed from these two species and the group was subsequently referred to *Achyranthes aspera* L. var. *pubescens* (Moq.) Towns. or intermediate(s) between var. *aspera* and var. *pubescens* by C. C. Townsend (Kew).

In Volumes 1 and 3 of the FLORA OF THE TAMILNADU CARNATIC series (Matthew 1981, 1983), published before this determination was received, some inaccuracy had crept in and in the former work this taxon was referred to partly under *A. bidentata* Blume (RHT 24561) and partly under *A. aspera* L. (RHT 1124, 20544), while in the latter work, the description of A. *bidentata* Blume includes these three specimens as well. This error is intended to be cleared up in the following key and illustrations of the three taxa.

1 Leaves oblanceolate, 7-18 x 2.5-4 cm, sparsely hirsute, apex gradually acuminate. Staminal sheath truncate or minutely dentate .... ***A. bidentata***

1 Leaves elliptic to (ob)ovate, 4-8 x 2.5-5 cm, thinly pubescent, apex obtuse to subacute. Staminal sheath fimbriate.................... ***A. aspera***

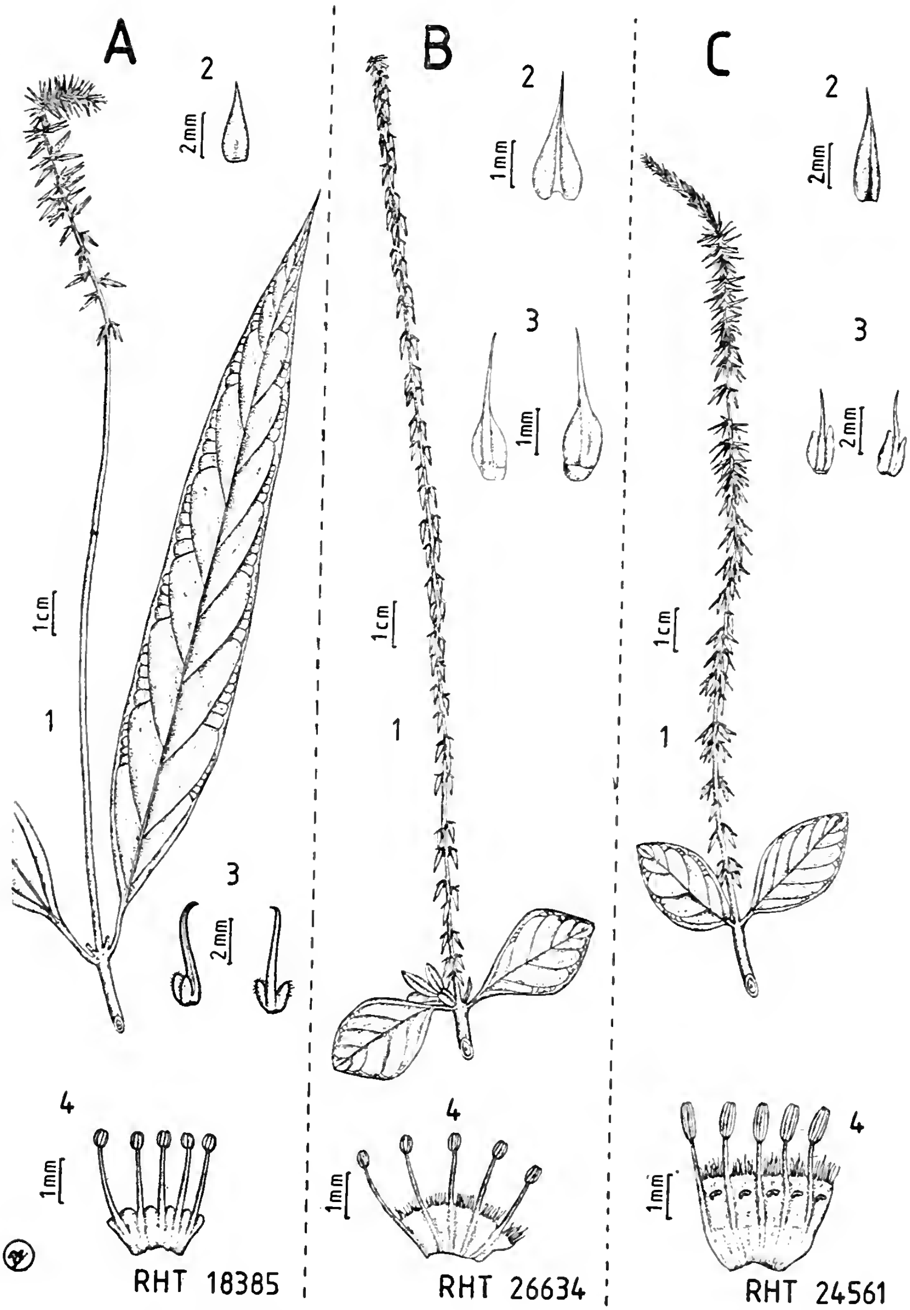
2 Bracts broadly ovate. Wings of the bracteoles equal, entirely adnate to the midrib. Staminal sheath obscurely fimbriate. Fruiting perianth strongly deflexed, $< 4(5)$ mm long............ .... var. ***aspera***

2 Bracts lanceolate. Wings of the bracteoles unequal, apically free. Staminal sheath clearly fimbriate. Fruiting perianth horizontal or moderately spreading, $> (5)6$ mm long........... .... var. ***pubescens***

Specimens examined: C. C. Townsend (Kew) has kindly determined the identity of the following specimens: RHT 18385 (*A. bidentata*): RHT 26634 (*A. aspera* var. *aspera*): RHT 24561 (intermediate between var. *aspera* and var. *pubescens;* "it has the larger flowers of var. *pubescens* and the broad apiculate leaves of var. *aspera*" (pers. comm.). See also C. Townsend (1973 & 1974).

N. RANI

THE RAPINAT HERBARIUM,
ST. JOSEPH'S COLLEGE,
TIRUCHIRAPALLI 620 002,
November 24, 1984.



(A) *Achyranthes bidentata* Blume (RHT 18385); (B) *Achyranthes aspera* L. var. *aspera* (RHT 26634); (C) *Achyranthes aspera* var. *aspera-pubescens* intermediate (RHT 24561).

1. Twig; 2. bract; 3. bracteoles; 4. staminal sheath, split open.

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RANI, N. & MATTHEW, K. M., IN MATTHEW, K. M. (1983): The Flora of the Tamilnadu Carnatic. 1298.

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——————— (1974): Notes on Amaranthaceae. *Kew Bull. 29*: 473.

ERRATA

Volume 81(3): December 1984

Miscellaneous Note

5. A note on antler casting of barking deer (*Muntiacus muntjak*) in captivity.

On page 690, right side column,

Table to be read as under:

Length in cm	Weight in gm
5.00	7.400
6.50	8.600
7.00	11.500
7.75	12.500
10.00	17.000
10.00	17.700
10.00	20.500
10.50	12.300
11.00	16.900
11.00	25.200

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2. The MS. should be typed (double spacing) on one side of a sheet only, and the sheets properly numbered.

3. All scientific names to be printed in italics should be underlined.

4. Trinomials referring to subspecies should only be used where identification has been authentically established by comparison of specimens actually collected.

5. Photographs for reproduction must be clear and show good contrast. Prints must be of a size not smaller than 8.20 × 5.60 cm (No. 2 Brownie) and on glossy glazed paper.

6. Text-figures, line drawings, and maps should be in Indian ink, preferably on Bristol board.

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STATUS OF BLACKNECKED CRANE IN LADAKH — 1983 PROBLEMS AND PROSPECTS[1]

S. A. Hussain[2]

(*With two plates*)

Introduction

Cranes, wherever they occur, have attracted the attention of mankind down the ages. Their sheer graceful demeanour, the trumpeting unison call that haunts the mind long after the echoes are stilled in the air, the empyrean ballet of courtship display and that special aura of eternal pair bond had caught the imagination of man as he ploughed his fields, tended his cattle or gazed down from the monasteries and temples, overlooking grassy meadows and marshlands. Poems have been composed, legends have been intervoven with the folk art and religious anecdotes and from all these emerged a special awe, almost bordering on reverence for the cranes which were considered to be symbols of love, prosperity and good luck wherever they occurred. It was therefore not surprising that the cranes, which build their nest in the open ground, were not only unharmed by man but were actually welcomed within his domain as harbingers of good luck.

Of the world's 15 species of cranes the Blacknecked Crane is perhaps the only species that had eluded the critical scrutiny of both professional biologist and amateur naturalist, retaining its aura of Tibetan mysticism, and carried on its existence sharing the precious marshlands with man and beast.

Distribution

The Blacknecked Crane is perhaps the only crane in the world having an exclusive distributional breeding range between the altitudes of 3500 m and 5500 m in the tablelands of central Asia, and also an equally unique

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migratory pattern. Ever since Przeswalski, that great Russian naturalist-explorer discovered them near lake Ko Ko Nor in northern Tibet there has been but a sporadic trickle of information about their sighting or breeding. Cranes have been recorded from extreme eastern Ladakh (breeding), southern, south central and southeastern Tibet (breeding/passage migratory) Central Bhutan and Arunachal Pradesh (wintering) to Szechwan and Yunnan (breeding/migratory/wintering) and Vietnam (wintering) to its eastern limit. A review of whatever fragmentary data we so far have suggests that there are two distinct populations polarized at either extreme of the Tibetan tableland and a winter dispersal pattern that looks like a crescent on a map. The eastern population, which moves in a north-south course, has a clear-cut breeding area in the high altitudes and a wintering area at least about a thousand kilometres southwards in the lowlands of Vietnam. In contrast the status and distribution of the western population is rather confusing. Breeding and passage areas seem to overlap along a crescentic tangent from Ladakh up to the lower hills of north-eastern India, skirting the northern faces of the Himalayas along the southern approaches of the Tibetan Plateau. However, our knowledge of the birds in these areas is scanty and judging from the records available to us it can be hopefully assumed that somewhere beyond the bamboo curtain, safe from international intrigues, the cranes are fairly plentiful in numbers. The records of the cranes congregating in considerable numbers (wintering in Bhutan *c.* 35, 1980) Zining, Tsinghai, provinces of China (10 nests, 17 eggs), and the information that surfaced during the recent International Ornithological Congress in Moscow in August 1982, leads one to believe that the actual situation may not be as alarming as is generally assumed to be.

The information on the occurrence and distribution of the Blacknecked Crane within Indian limits had been, until recently rather scanty, except for two major ornithological expeditions, one in 1925 by that indomitable pioneer of Indian ornithology B. B. Osmaston, followed closely by another irrespressible naturalist, Col. Meinertzhagen, both of whom in the course of their sojourn saw but two or three pairs in Ladakh. Elsewhere within the Indian limits they have been reported to occur in Bhutan and NEFA (present Arunachal Pradesh).

Habitat overview

The Tibetan Plateau is perhaps one of the least studied and explored among the world's different faunal regions. The plateau is characteristically a bleak wind-swept desert and barren hills where arctic conditions prevail. A review of the pattern of occurrence and distribution of the biota of this region shows a dominance of specialised endemic and general species of plants, insects and other animals which were perhaps driven there due to intense competition in their original habitats. The wetlands and marshes throughout the plateau support complex biotic communities providing the last strongholds for the delicately balanced high altitude forms. This phenomenon is similar to the conditions prevailing in oceanic islands and the environmental factors that influence the habitat and biota in such islands may as well apply here. Due to political and other reasons it is not possible to assess the existing conditions and status of the fauna and flora of the major portion of the Tibetan Plateau. The only accessible portion lying within the Indian territory is Ladakh which forms the southwestern extremity of the plateau.

The lakes and wetland areas of Ladakh support a high altitude biota and offer an opportunity to study the Tibetan ecosystem and its animals and plants. Basic data about the lake ecosystem, geology and insect fauna are available, but recent information concerning the status of its mammals and birds is lacking.

Geographic features

Ladakh occupies an area of roughly 83168 sq. km in the eastern portion of Jammu and Kashmir State. Four main mountain ranges, the Himalayas in the east and then Zanskar, Ladakh and Pangong ranges traverse NW-SE. The main body of the massive Karakorams which lie north of the Shyok river provide the northwestern border for the tableland. The vegetation zonation is sharply defined beyond the eastern facies of the main Himalayan range. As one negotiates the Zojila (Pass) *c.* 3600 m on the way to Leh the HQ Town of Ladakh, the lush green tree line of the Kashmir Valley abruptly gives way to a bare, rocky landscape, with isolated pockets of poplar and willow groves around village cultivation.

The main rivers, the Indus and Shyok run along either side of the Ladakh range on a SE-NW course until both meet and turn sharply southwest in Baltistan. The three main ranges of Karakoram, Ladakh and Zanskar, divide the entire area into the broad valleys of the Shyok, Indus, Rhupshu and Zanskar. The last two collectively known as Changtang, contain the four major lake systems, the Pangong, Tso Moriri, Tso Kar and Mitpal Tso, besides some other smaller water bodies. The wetlands and marshes are scattered around the lake regions.

Climate

The climatic conditions are harsh. The entire area is under heavy snow during the winter and the lakes and rivers freeze. Summer sets in late May when most of the snow melts except in the higher peaks, and warm conditions prevail till late September. The intensity of solar radiation is very high due to the thin and rarified atmosphere. The contents of oxygen-nitrogen-carbondioxide combined varies conversely with altitude. Another characteristic aspect of such high altitude environments is the quick changes in atmospheric temperature brought on by strong winds often culminating in dust storm.

Climatic oscillations through the years have had a detrimental effect on the physiography of the area. Rate of precipitation, fluctuation in the lake levels, rainfall and glacial movements phenomenon have a direct impact on the entire ecosystem.

Rainfall and Temperature

Rainfall is higher in the Suru and Dras valleys and gradually decreases eastwards. The average annual rainfall as recorded at Leh and Kargil is about 30 mm for the year 1975. This includes snowfall (computed at 250 mm snow — 25 mm rain). This is considerably less than the seasonal average for the years between 1880 to 1930, when the average stood around 75 mm. The maximum temperature recorded at Leh in 1975 was 23.8°C and at Kargil 39.9°C and the lowest temperature at Leh, 17.4°C and at Kargil, 12.4°C. Temperature around lake regions could be much lower.

Vegetation

Most of the vegetation is confined to moist valleys flanking glacial streams and the main

river systems. The broad flat marshes also host several species of stunted vegetation, mostly Cyperaceae and flowering plants. Willows and poplars occur in the river valleys.

The dominant high altitude vegetation of Ladakh at an average elevation of *c.* 3400 metres is mainly the thorny scrub *Lonicera spinoides,* with an average height of 2 ft and *Hippophae rhamnoides;* between the altitudes of 3657 and 4267 m small white flowers of *Myricaria cyane* are common. The vegetation of altitudes above 4300 m consists mainly of Tibetan furze *Caragana* sp.

Present status of Blackneckfd Crane

The present status of the cranes is based on a series of exploratory forays into Ladakh initiated by the Joint BNHS — WWF Expedition to Ladakh in 1976 and followed by two more and a third to their wintering quarters in Bhutan. The 1976 expedition led by Dr. Sálim Ali visited the three known breeding areas. On the way to the first of the areas at Chushul, the expedition was greeted by the sight of an egg in the process of being taken to Leh. Predictably, one third of the Ladakh breeding population had suffered, thanks to some thoughtless collector of eggs. Deprived of their eggs, the Chushul pair was wary of human approach. A second pair was observed with a week-old chick at Hanle. Altogether five cranes (two pairs and a singleton) were seen during the expedition. The second visit by Prakash Gole in 1978 saw almost the same number in the same areas, but this time (early June) the Chushul pair was observed incubating two eggs. (It was subsequently learnt that the eggs were destroyed due to floods in the marsh.) The third sojourn resulted in a wider coverage of the area.

In the meantime the Jammu and Kashmir wildlife department reported sighting of 17 cranes in Ladakh in 1982.

Background

At the International Crane Workshop held at Bharatpur in early 1983, it was emphasised that the Blacknecked Cranes in their breeding areas are threatened, and captive breeding of the species was advocated. The delegates from India drew a rather dismal picture about the breeding status in Ladakh, though according to one delegate, 17 cranes had visited the area in 1981. The Chinese delegation spoke about their studies on 10 nesting pairs in Tsinghai province and mentioned the sighting of Blacknecked Crane flocks on passage different parts of the central Asian tablelands. It was apparent that the populations in eastern Tibet are perhaps better off than those on the western periphery, especially in Ladakh. There is definite evidence of at least 30-35 cranes wintering in Bhutan and these were said to be from the western population. If so, by simple deduction, it is apparent that : (*a*) there is a bigger population breeding in Tibet, east of Ladakh, or (*b*) there is a third population breeding somewhere north of central Bhutan. In the recent years there has been a flow of some authentic information on the status of Blacknecked cranes. The report of the Crane Working Group of the XVIII World Conference of the ICBP held at Cambridge, England, in August 1982, quoted the report of the Institute of Zoology, China findings of 140 wintering cranes in western Guizhon province near Yunnan. The report also mentioned 12 captive cranes and the establishment of a research centre near Zining in Tsinghai province. A paper on the distribution of Blacknecked Cranes in China, presented at the 18th International Ornithological Congress in Moscow

1982, by Ma Yi-Ching mentions about large migrating flocks of 300-400 Blacknecked Cranes at the Tangra Range and another flock of 600 in the Tsaidan Basin. It is apparent that the status in China is quite encouraging.

Present survey

As mentioned earlier, one of the main reasons for the need to assess the present breeding status of the Blacknecked Crane in Ladakh was due to the opinion expressed by a section of the delegates to the International Crane Workshop at Bharatpur that captive breeding was the only solution for the rehabilitation of Blacknecked Cranes and that urgent efforts should be made to collect at least 10 eggs, during current season, and should be sent to International Crane Foundation in Baraboo, Wisconsin for artificial incubation and hatching. It was also mentioned that a captive breeding centre should be established in India at a later stage. A resolution to the above effort was passed at the conclusion of the Workshop. An attempt was also contemplated jointly by the International Crane Foundation authorities and the Jammu & Kashmir Wildlife Department to collect crane eggs from Ladakh.

Serious doubts about the feasibility of obtaining eggs from Ladakh were expressed by the Bombay Natural History Society and the haste with which the egg collecting programme was being pushed through both by the International Crane Foundation and the Jammu & Kashmir Wildlife Department without prior clearance from the Government of India, was objected to by Dr. Salim Ali both as the President of the Bombay Natural History Society as well as Vice Chairman of the Bird Wing of the Indian Board for Wildlife. As a consequence a joint BNHS/WWF expedition was proposed with the following aims and objectives.

Aims and objectives

(*a*) To determine how many pairs of Blacknecked Cranes actually breed in Ladakh; (*b*) the breeding success; (*c*) whether it is feasible/advisable to collect eggs for captive breeding; and (*d*) to gather information on the breeding biology and behaviour of the Blacknecked Cranes in Ladakh.

Itinerary

The team comprising of Vice Admiral M.P. Awati (Rctd.), Prakash Gole, WWF Representative, and S. A. Hussain (BNHS) reached Leh, Ladakh on 22nd May 1983. After a short period of acclimatization at Leh during which period, expedition details were discussed and finalised with the Army authorities, the party left for eastern Ladakh. It was decided, firstly to visit all the areas where the cranes were claimed to have been seen by the earlier reports, and secondly once the nesting pairs had been identified to spend more time at each nesting site to study the breeding biology and fledging success. The duration of the entire trip was to depend upon the feasibility of monitoring nesting pairs.

The team travelled about 1000 km by jeep and ponies, spent 24 days in the field, and visited 5 marshes in different parts of eastern Ladakh.

Survey

Harong Lake. First in the series of the areas investigated was Harong Lake, *c.* 4500 m. The 'Lake' supports extensive grassland ideal for cranes but no cranes were seen. The local shepherds in the area also mentioned, when questioned, that they had not seen any cranes in this area previously.

Chushul (28th May-22nd June 1983, and 17/18th June)

Chushul has a pair nesting in a marsh at the northern periphery, just below Furchuk La. Two eggs were laid on a flat mound in the middle of a boggy marsh. The pair, though wary of visitors initially, accepted our presence onee they got used to the observers. Eventually, the pair was incubating at intervals. A singleton was also seen at a nearby marsh. However, the eggs were reported missing on 7/8th June, and birds had deserted the area by 17th June.

Fuckche (3.6.83 to 5.6.83)

The cranes were reported from a marsh on the banks of the Indus by the Forest personnel. No cranes were seen during the present trip.

Hanlé (5.6.83 to 6.6.83, again on 16.6.83)

One pair was ineubating at Lal Pahadi, *c.* 15 km short of Hanlé on the Loma-Hanlé traek. The nest was *c.* 50 m from the track situated on a mound in the middle of a small pool of water. The pair was ineubating at intervals. Though the locals mentioned having seen the cranes in Hanlé marsh in the previous years, there was no report of them nesting there ever sinee 1976. The crane pair at Lal Pahadi were seen still ineubating during our subsequent trip on 16.6.1983.

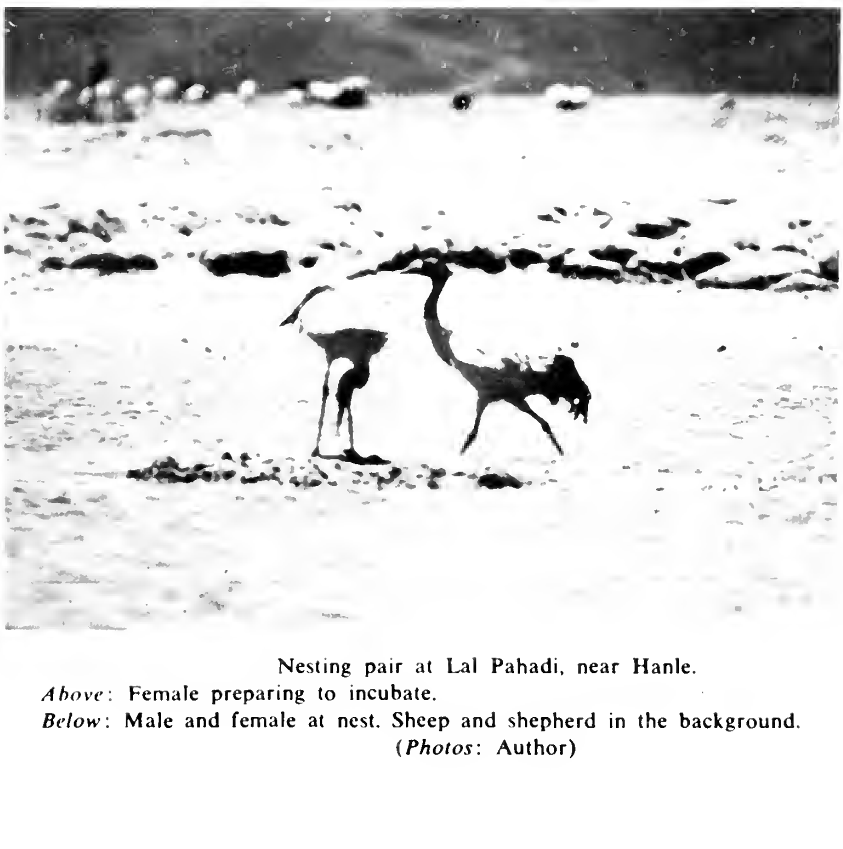
Puga/Tso Kar (7.6.83 to 10.6.1983)

One pair was seen near Tugzhe Gompa on 7.6.83. No evidenee of nesting but some kind of display by the pair was noticed. The weather deteriorated during the next two days and the eranes were not seen on a subsequent trip.

Assessment of Nesting

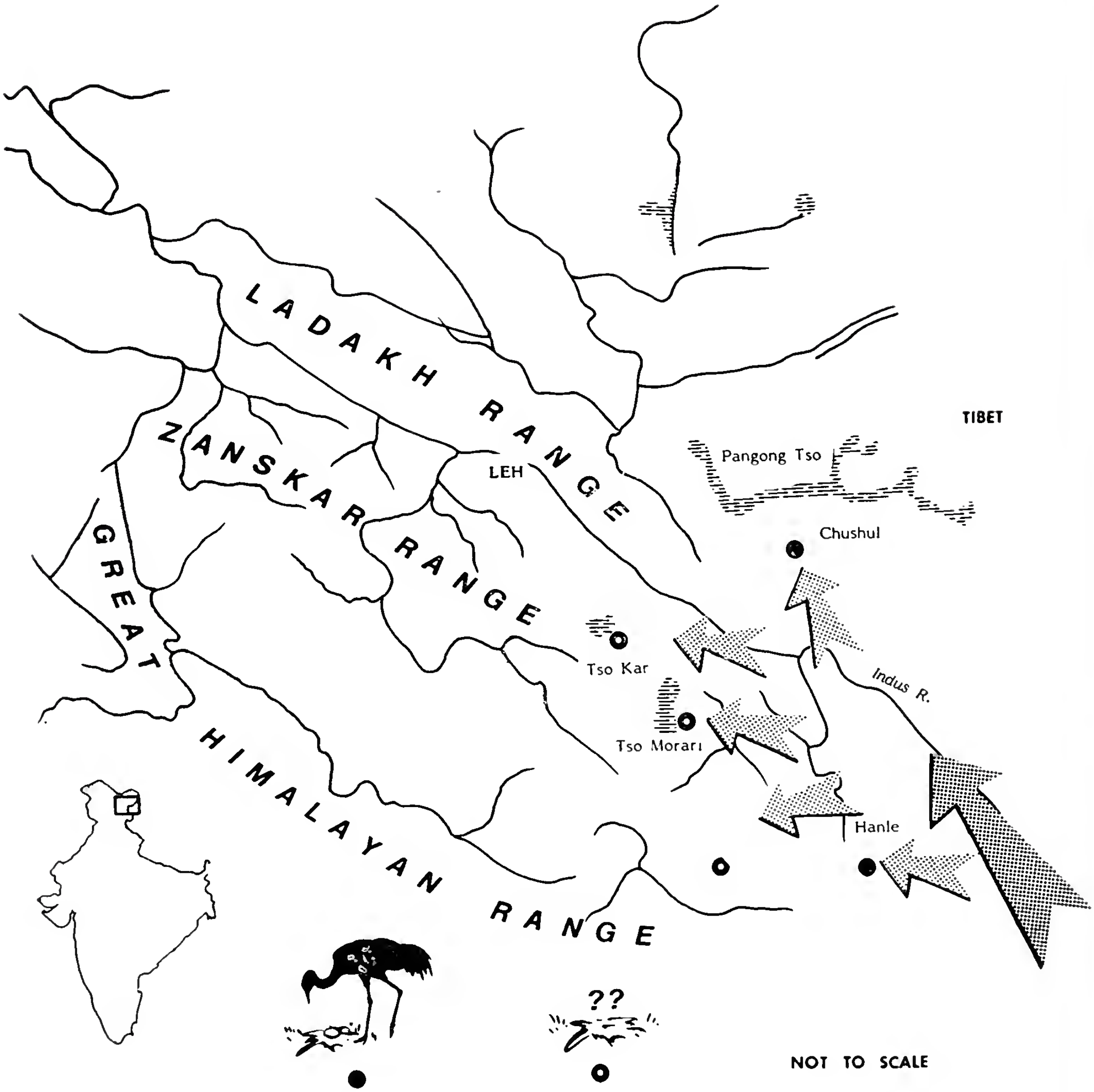
1. *Chushul.* The pair had nested on a bare mound in the middle of a small boggy marsh north-west of Chushul Village. The marsh (one of the many in the area) is well concealed between flat-topped sand dunes, and as such it was extremely difficult to detect its presence unless one actually elimbed the flat-topped mounds. Gole in 1978 had found a nest in the same marsh and once again in 1980. Chushul is one of the largest villages in the extreme eastern Ladakh, and is one of the traditional breeding areas of at least one pair. In 1976 the Chushul pair had lost its eggs due to some curious locals' enthusiasm to show the eggs to authorities at Leh.

There is no clear information on the nesting success of the Chushul birds. Nobody, loeals, civil and military authorities stationed there seem to be aware of any recent nesting success. Reports of eranes' occurrence, nesting or incubating is available, though rather sketehy, but nobody seems to be aware of the birds actually raising ehick/s and successfully flying off with the young ones at the end of the breeding season. An army officer, stationed in that area, however, showed a colour photograph of five eranes feeding in a marsh in Chushul. The photograph had been taken in October 1982. According to him the cranes remained in the marsh till late Oetober and were rather tame, allowing a elose approach. Of the five eranes, three appeared to be definite adults while two were obviously younger birds but were not the brood of the year. Our estimate was that these birds were at least two years old. What then is the nesting status at Chushul ? It is obvious that, whether they are sueeessful or not, or whether they were disturbed at nest or not, the cranes (are they the same pair?) do visit Chushul every summer. How long will they continue to come ?



Nesting pair at Lal Pahadi, near Hanle.
Above: Female preparing to incubate.
Below: Male and female at nest. Sheep and shepherd in the background.
(*Photos*: Author)

PLATE II



Breeding locations of the Blacknecked Cranes.

Hanlé Nesting Success

The status of Hanlé birds is more or less the same as Chushul, but there was definite evidence of the pair raising at least one chick (Sálim Ali *et al.* 1976, Gole 1978, 1980). However, lately the pair seems to have moved out of the Hanlé marsh, and has found a suitable nesting site in a marshy ground about 18 km short of Hanlé on the Loma-Hanlé road. They were observed visiting Hanlé marsh occasionally to feed. Information about successful hatching was later relayed by the army authorities.

Tso Kar/Startsapuk Tso

This area is perhaps the best and safest breeding ground for the crane. The lakes are situated well away from human habitation except for a small hamlet situated on the northern corner. During this trip the pair was seen still displaying and it was obvious that the nesting had not yet started. Unfortunately due to inclement weather, it was not possible to gather more data on their behaviour. However, there were encouraging reports of the visiting pairs having successfully reared young in the previous years.

Conclusions

The evidenee so far gathered suggests that the population Blacknecked Crane in Ladakh has been constant for the past 50 years. One pair each nests in Chushul, Hanlé and Tsokar while unmated (?) singletons also visit these areas. There are possibilities of cranes occurring in the southern edge of Tso Morari but definite evidence is not available. It is now obvious that Ladakh is a peripheral breeding ground for the Blacknecked Cranes and a larger and more suitable areas exist on the Tibetan Plateau. Recent information available from China indicates that Blacknecked Cranes do occur in large number in Chinghai (breeding), Zechuan (breeding), Quizon (wintering). Chinese researchers have found several cranes breeding in a 45 km^2 area is Qighai province.

Gole and Lavkumar have reported having seen about 35-40 Cranes wintering in Bhutan in 1980. It is possible that these cranes are part of a population that exists somewhere between the eastern and western population.

Conservation outlook

1. *Status*

It is now obvious that the Blacknecked Crane as a species is not as rare as it has been believed to be. Lack of information, inaccessibility of the areas where they occur, and their exelusive movement patterns may have led the conservationists to conclude that they are extremely rare. In recent years it is encouraging to note that more information is fortheoming regarding their status and the Chinese ornithologists are making serious efforts not only to study them in the wild also safeguard their nesting/wintering areas. The information is about the establishment of a study-cum-breeding centre in Chinghai province in China.

2. *Status in Ladakh*

The marshes in extreme eastern Ladakh bordering Tibetan Plateau have been the traditional breeding areas of at least three pairs of eranes. The cranes arrive in the area in early May, passing through the Indus Valley as the river enters Indian territory and move along the river banks, finally arriving in three or four traditional breeding marshes (Plate II). The nest there and remain till about end of Oetober before moving towards their winter quarters. The population estimates put out by the state

Forest Department for the year 1980-82 may not be accurate as it would seem that the cranes were counted many times over on passage to breeding marshes.

Conservation problems

1. *Captive breeding*

One of the aims of this expedition was to examine (*a*) feasibility, (*b*) possibility of establishing an artificial incubation centre for captive breeding the cranes in India, preferably in Ladakh. Considering the difficulties and lack of proper facilities such as transportation, equipment, impracticability of collecting cranes' eggs from several nests simultaneously within a particular incubation period, such a programme is not presently advisable. On the contrary it would be sensible to look at the status of the habitat of the nesting cranes in their traditional nesting sites in Ladakh, and safeguard these with all available resources.

2. *Habitat assessment*

In the past few years it is becoming increasingly apparent that population pressures, both human and livestock, as well as from free ranging animals such as the Tibetan Wild Ass on the marsh ecosystem is becoming more and more acute. Since these high altitude marshes have a very restricted and critical life span available to them in the summer months and the entire life forms of the ecosystem are dependent on this period the pressure would be specially heavy. The increase in human population has consequently brought in a greater number livestock as is apparent from the information available from the local administration. The very survival of livestock is rather bleak during the lean season as well as in the winter months. What effect will this have on indigenous flora and fauna by the competition posed by the greater number of domestic livestock? Apart from this there is also evidence of the fact that even under natural conditions the life sustaining water flow system into the marshes fluctuates to a great extent, jeopardising the seasonal stability.

Management — Problems and possible Solutions

1. *Problems*

As mentioned earlier, there is an urgent need to study the status of the wetlands of eastern Ladakh and identify the problems. The problems seem to be both natural and man-made. Habitat manipulation to the advantage of a species affected, even by natural cause, is advocated, considering the limited number of cranes that come to Ladakh and the critical time and space factor that controls their breeding success.

A. *Natural causes*

High altitude wetland systems, especially those in eastern Ladakh, depend mainly on the water received from the melting snow since the rainfall in these regions is virtually non-existent. The inflow into such ecosystems is completely dependent upon the climatic conditions.[3] Thus a late summer would deprive adequate life giving water supply to these marshes resulting in a delay in the ecological process very necessary for the regeneration of a host of life forms of the area. In the case of the Cranes this also means, apart from non-availability of marshland food supply, lack of

[1] The water inflow is temperature controlled. Even feeder streams are frozen in the morning and start melting only if there is adequate sunlight.

safe nesting sites due to the absence of boggy marshes. The most critical period would be, as evidenced in the case of Chushul nesting pair, when the oscillating weather conditions completely jeopardise the water regime of the marshlands. When the Chushul pair arrived there, the marsh had just received enough snow melt to provide a minimum nesting condition (i.e. emergence of aquatic food plants plus a promising bog to nest). However, the weather conditions changed at a critical period when the incubating pair needed the maximum safety, as the water inflow virtually stopped due to drop in temperature thus stopping snow melt and resulted in the marsh drying up rapidly. The crane eggs were vulnerable to predation/disturbance, and as a consequence the pair lost their eggs. On the other hand, in a reversal process increased melting of snow due to excessive radiation during early summer, causes the flooding of the same marshes, resulting in disaster for the nesting crane pair. Once again, during one such season the Chushul pair lost their eggs due to excess flooding of their nesting marsh.

B. *Manmade causes*

One of the main factors that went in favour of the nesting Cranes in Ladakh so far had been the socio-religious protection the cranes enjoyed there. While the cranes accepted the presence of man and his live stock very close to its nest sites the inhabitants actually looked upon the nesting pair as a sign of prosperity and took care not to disturb them. However, this atmosphere of peaceful co-existence would not last long as the sociological, political, and economic conditions are bound to change and such a process is already accelerated due to the recent happenings in the adjoining border areas.

One of the main considerations for the advancement of the economic conditions of the people in the remote areas in Ladakh is animal husbandry. Since all other considerations, including, agriculture have a very limited scope, greater emphasis is laid on increasing the livestock. Unfortunately in their zeal to increase the livestock populations no serious thought seems to have been given towards the life-support system of these livestock resulting in (*a*) a severe strain on the existing pasture lands, (*b*) excessive loss of life during winter months due to shortage of food for the livestock and people, as well as competition for space has adversely affected the successful breeding of the cranes in these marshlands. The increased presence of shepherd dogs is also a potential threat to rearing crane chicks, as is the steep rise in the number of other predators in the area such as ravens, foxes, wolves that follow the nomadic shepherds.

An increase in the human population has also placed a corresponding pressure on the prime space for habitation as well as to a lesser degree, agriculture. The tendency seems to be to reclaim areas most advantageous both in terms of suitable land and access to water courses. The trend noticed recently in Ladakh is to alter waterflow system into the marshes — in some cases completely diverting the water flow — so as to reclaim land for housing and agriculture/pasture lands (Hanlé marsh is a typical example).

2. *Suggested solutions*

Acknowledging the fact that the main threat for the Blacknecked Cranes in Ladakh is the rapid increase in the loss of nesting habitat and the disturbance caused by the increase in human population pressures, the following solutions are strongly recommended with emphasis on speedy action from the concerned authorities:

1. ABSOLUTE PROTECTION OF ALL RECOGNISED TRADITIONAL NESTING SITES ESPECIALLY DURING BREEDING SEASON.
2. MANAGEMENT OF WATERFLOW SYSTEMS TO THE NESTING MARSH.
3. CREATION OF A SPECIAL FIELD FORCE FOR MONITORING/PROTECTING BREEDING PAIRS/CHICKS.

1. Cordon off a minimum area around the nest site and prohibit all activities within a perimeter of at least one kilometre. No habitation, permanent or temporary (tenting), should be allowed in the nesting marsh. If necessary a low fencing to keep off livestock, dogs, etc. should be erected in the above 1 km perimeter.

2. Waterflow system to the nesting marsh should be monitored so as to keep it at a constant level. Drainage system in case of excess flooding and artificial feeder system in case of decrease in inflow regime, should be established.

3. A special task force of the Dept. of Wildlife drawn both from the state and centre, should be stationed at all known nesting areas. The task force, consisting of a field researcher, and watch and ward staff should remain in the vicinity of the nesting marsh from early May to end of October.

The details of the above should be worked out by the J&K State Wildlife Department with the collaboration of Dept. of Environment, Govt. of India, Ladakh District Civil Administration, Defence authorities stationed in Ladakh (including paramilitary organisations), and the Bombay Natural History Society and the World Wildlife Fund in advisory capacity.

ACKNOWLEDGEMENTS

Assistance received at all levels from the Defence authorities is gratefully acknowledged. Excellent cooperation received from my colleagues, Adm. Awati, and Prakash Gole is equally appreciated.

A REVIEW OF THE GENUS *SORICULUS* (MAMMALIA: INSECTIVORA)[1]

ROBERT S. HOFFMANN[2]

(With six text-figures)

The red-toothed shrews (subfamily Soricinae) of eastern Asia include six genera. *Blarinella* and *Sorex* are included by Repenning (1967) in the tribe Soricini, while the superficially similar long-tailed shrews of the genus *Soriculus* (sensu lato) he placed in the tribe Neomyini, together with the more specialized mole-shrew (*Anourosorex*), and water shrews (*Chimarrogale, Nectogale*). None of these genera has received systematic attention in recent years, and it is my intent to clarify certain problems of nomenclature and systematic relationships that I have encountered during the course of a more extensive study of Holarctic mammals.

The genus *Soriculus* Blyth, 1854 is here employed in a broad sense to include, as subgenera, *Chodsigoa* Kastschenko, 1907, and *Episoriculus* Ellerman and Morrison-Scott, 1951. These latter two are sometimes considered genera (Repenning 1967, Jameson and Jones 1977). The distinctions between these taxa involve small differences in shape of articular facets of the mandible, amount of reddish dental pigmentation, number of upper unicuspid teeth, and relative proportions of teeth, forefeet and tail. These characters, while useful in defining groups, are variable, and a single inclusive genus is employed here.

Soriculus is found from northern China southward to northern Vietnam, Thailand, and Burma, on Taiwan, and westward along the Himalayas to Kashmir. Within this area, Ellerman and Morrison-Scott (1951) recognized six species: 1) *Soriculus* (*S.*) *nigrescens* Gray, 1842 including *caurinus, centralis, pahari,* and *radulus*; 2) *S.* (*Episoriculus*) *caudatus* Horsfield, 1851, including *baileyi, fumidus, sacratus,* and *umbrinus*; 3) S. (*Episoriculus*) *leucops* Horsfield, 1855 including *macrurus* and *irene*; 4) *S.* (*Chodsigoa*) *hypsibius* De Winton, 1899 including *lamula, larvarum,* and *parva*; 5) *S.* (*Chodsigoa*) *salenskii* Kastschenko, 1907 including *furva, parca,* and *smithii,* and 6) the monotypic *S.* (*Chodsigoa*) *lowei* Osgood, 1932. *Chodsigoa sodalis* Thomas, 1913, was left *incertae sedis*; the name was based on a single skull from Mt. Arisan, Taiwan, 8,000 ft., which is also the type locality of *S.* (*E.*) *fumidus.*

Honacki *et al.* (1982) recognized ten species based on further work: 1) *S. baileyi* was considered distinct from *S. caudatus,* since Abe (1971) found them to be sympatric in Nepal; 2) *S. fumidus* was elevated to specific rank and *sodalis* was included following Jameson and Jones (1977); 3) *S. gruberi* Weigel, 1969, was recognized as new; and 4) *S. smithii* was considered specifically distinct from *S. salenskii,* based on Corbet (1978); Corbet and Hill (1980) recognized all of the above but *baileyi.*

As a result of my work, I also recognize ten species of *Soriculus,* but the composition

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of these species is, in some cases, quite different from the present view.

Materials and Methods

Holotypes of most of the named forms listed above have been examined, as well as series of *Soriculus* from throughout the range of the genus (see Specimens Examined). Three external measurements were taken, where available, from collector's original labels. Seven cranial measurements were made to the nearest 0.05 mm with dial calipers. These included: 1) condyloincisor length (CIL), occipital condyles to anterior tips of first incisors; 2) cranial breadth (CB), greatest breadth of braincase, approximately across the mastoids; 3) maxillary breadth (MB), greatest distance between tips of maxillary processes; 4) M^2 to M^2 breadth (M^2-M^2), greatest distance between anterior labial margins of second upper molars; 5) interorbital breadth (IOB), least lateral diameter of skull at anterior end of orbits, just posterior to maxillary processes; 6) palatoincisor length (PIL), posterior margin of palate in midline to anterior tips of first incisors; 7) upper tooth row length (UTRL), greatest length of tooth row from posterior margin of alveolus of M^3 to anterior tip of I^1. These measurements were selected for the speed and accuracy with which they could be made, and in some cases differ from those of earlier investigators. For example, condylobasal length is a traditional measure of skull length, but it is usually difficult and time-consuming to measure the anterior margin of the premaxillary bone. Employing the anterior tips of the first incisors for the anterior terminator results in a more accurate and repeatable measurement.

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Results

Soriculus (Soriculus) nigrescens Gray, 1842. Ann. Mag. Nat. Hist. 10: 261. Type locality: Darjeeling, West Bengal, India.

This is a large *Soriculus* with fossorial adaptations. It retains four upper unicuspid teeth, a primitive state for the genus, but its enlarged forefeet and claws, relatively short tail, reduced M_3 and entoconid crest of M_1, and spatulate coronoid process (Repenning 1967) are derived characters associated with its fossorial habits. Thomas (1922) described *S. radulus* on the basis of two specimens that were smaller than typical *nigrescens*, and Hinton (1922) subsequently described three new subspecies of *nigrescens* based upon differences in size and color. The magnitude of these differences among samples is small, however, throughout most of the geographic range of *S. nigrescens* (Table 1). Mitchell (1977), on the basis of 245 specimens taken throughout Nepal, con-

TABLE 1

EXTERNAL AND SELECTED CRANIAL MEASUREMENTS OF *Soriculus nigrescens*

		Head-Body	Tail	Hind Foot	CIL	CB
S. n.	mean	85.2	43.8	15.1	22.67	11.93
"caurinus,"	range	79–94	41–48	14–16	22.6–22.8	11.7–12.2
Kumaon	N	10	10	10	3	3
S. n.	mean	83.2	42.5	15.9	21.81	11.4
"centralis,"	range	74–92	34–43	15–17	20.8–22.3	10.8–12.3
Nepal	N	13	13	13	4	4
S. n.	mean	80.7	41.5	14.4	21.97	11.45
nigrescens,	range	70–88	34–47	14–15.5	20.6–22.7	10.8–12.1
Darjeeling	N	41	41	41	3	3
S. n.	mean	86.7	42.2	15.5	22.87	11.39
"pahari,"	range	75–93	36–47	15–16.5	21.9–23.8	11.1–11.7
Sikkim	N	32	32	32	5	5
S. n.	mean	73.5	41.0	13.0	20.33	10.33
radulus,	range	70, 77	32, 50	12, 14	19.75,20.9	10.15,10.55
Burma	N	2	2	2	2	2

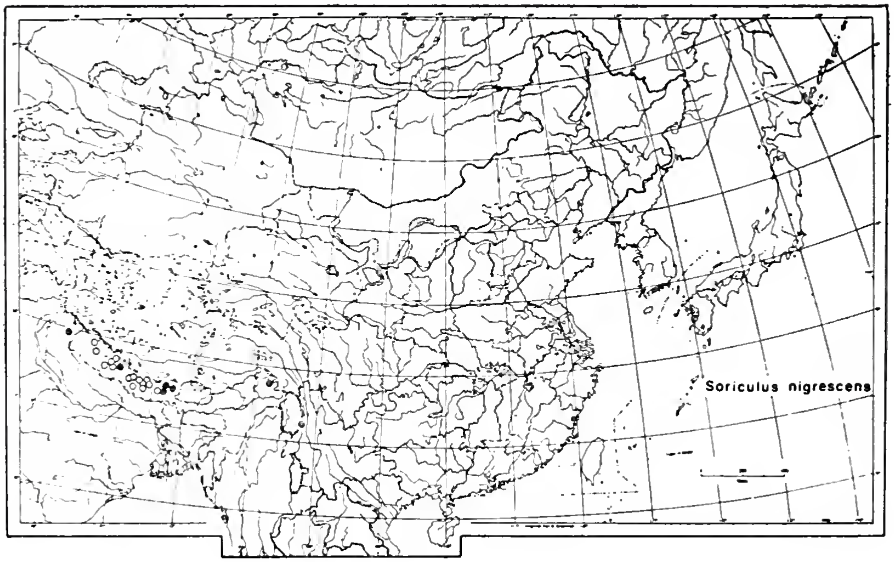
* in part from Hinton, 1922.

cluded that *caurinus, centralis,* and *pahari* were synonyms of *S. n. nigrescens,* and I concur. *Soriculus n. radulus* is distinctly smaller, but known from so few specimens that it is a best retained as a subspecies until it is better known, as was done by Ellerman and Morrison-Scott (1951).

S. n. nigrescens occurs at middle altitudes in the Himalayas from Kumaon throughout Nepal and Sikkim; *S. n. radulus* is known from two localities in northern Assam and southwest China, but is likely more widespread in the eastern Himalayas (Fig. 1a).

Soriculus (Episoriculus) leucops Horsfield, 1855. Ann. Mag. Nat. Hist., 16: 111. Type locality: Nepal.

There has been confusion concerning to which taxon this name should be applied. It is usually given to a light gray, very long-tailed form of moderate body size (cf. Anthony 1941, Abe 1971, 1982, Mitchell 1977). However, examination of holotypes in the British Museum (Natural History) revealed that the type specimen of *S. leucops* (BMNH 79.11. 21.483) is a large dark brown shrew with a tail only slightly longer than its body, and, approaching the type of *S. baileyi* (BMNH 14.1.1.1.) in size and colour (Table 2). Horsfield's (1855) description confirms this, for he states: "Colour uniform blackish-brown .... Length of the body 3 inches [76 mm], of the tail $3\frac{1}{4}$ in. [82.5 mm]." In contrast, the type of *S. macrurus* (see below) is of a smaller shrew, comparable to the pale gray, very long-tailed type of *S. irene* (BMNH 11.9.8.22) (Table 3). I conclude that *S. macrurus* is not a synonym of *S. leucops,* as Osgood (1932) listed it without comment. He was subsequently followed by Allen (1938) and others, all of whom employed the name *S. baileyi* for the larger, darker, relatively shorter tailed taxon, although Ellerman and Morrison-Scott (1951) incorrectly listed *baileyi* as a subspecies of *S.*



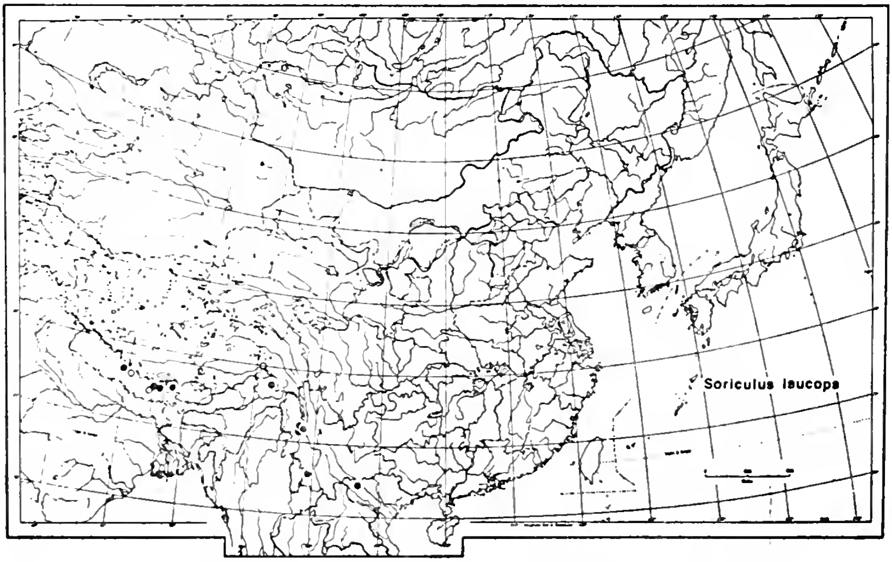


Fig. 1a (top). Distribution of *Soriculus nigrescens*. Solid symbols, specimens examined; open symbols, literature records (Abe 1982, Mitchell 1977).

Fig. 1b (bottom). Distribution of *Soriculus leucops*. Solid symbols, specimens examined; open symbols, literature records (Abe 1982, Feng *et al.* 1980).

TABLE 2

EXTERNAL AND SELECTED CRANIAL MEASUREMENTS OF *Soriculus leucops*

	Head-Body	Tail	Hind Foot	CIL	CB	MB	M^2-M^2	IOB	PIL	UTRL
S. l. leucops										
Holotype	76	82.5	—	19.60	9.74	5.60	–	–	8.60	8.55
Nepal mean	63.0	68.8	14.4	19.59	9.65	5.72	5.26	4.27	8.68	8.39
±SEm	3.92	4.30	0.87	0.18	0.08	0.05	0.07	0.08	0.07	0.07
range	53–76	58–82.5	12–17	19.1–20.0	9.45–9.9	5.6–5.9	5.0–5.45	4.1–4.45	8.45–8.95	8.15–8.55
N	6	6	5	5	5	6	5	5	6	6
S. l. baileyi										
Holotype	70	76	13	–	–	–	–	–	–	9.45
Yunnan, Gangfang mean	65.9	65.8	15.10	19.66	9.56	5.72	–	4.38	8.67	–
±SEm	0.89	0.92	0.28	0.08	0.04	0.05	–	0.02	0.05	–
range	58–74	59–72	14.19	19.2–20.2	9.2–9.8	5.35–5.95	–	4.2–4.55	8.35–8.95	–
N	17	17	17	15	15	15		15	15	
Burma										
mean	69.65	64.62	15.0	19.43	9.75	6.0	5.5	4.2	8.7	8.45
±SEm	1.04	0.99	0.24	0.11	–	–	–	–	–	–
range	63–77	57–70	12–16	18.8–20.2	–	–	–	–	–	–
N	17	16	17	14	1	1	1	1	2	1
Vietnam										
mean	72.75	71.75	14.25	20.59	9.82	5.58	5.21	4.21	9.11	8.76
±SEm	3.17	2.81	0.25	0.08	0.08	0.08	0.09	0.05	0.08	0.07
range	66–81	65–76	14–15	20.4–20.9	9.65–10.1	5.3–5.9	4.95–5.45	4.05–4.35	8.85–9.55	8.55–9.05
N	4	4	4	6	6	8	5	7	8	8

TABLE 3

EXTERNAL AND SELECTED CRANIAL MEASUREMENTS OF *Soriculus macrurus*

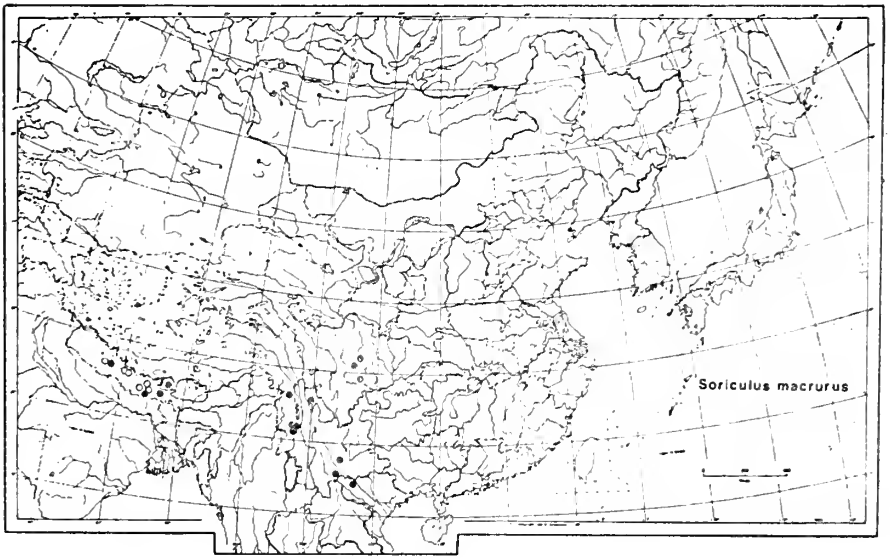
		Head-Body	Tail	Hind Foot	CIL	CB	MB	M^2-M^2	IOB	PIL	UTRL
Holotype		53.5	86.5	14.5	17.20	8.45	5.0	–	3.75	7.20	7.15
Nepal,	mean	61.25	86.5	15.83	17.52	8.71	5.24	4.71	3.90	7.80	7.51
Sikkim	±SEm	0.82	1.38	0.20	0.13	0.02	0.04	0.02	0.05	0.16	0.13
	range	55–66	79–94	14.5–17	17.0–18.35	8.65–8.75	5.15–5.3	4.65–4.75	3.8–4.0	7.4–8.1	7.15–7.7
	N	12	12	12	11	4	4	4	4	4	4
China	mean	61.7	85.1	15.46	17.59	8.65	5.19	4.74	3.96	7.56	7.46
	±SEm	0.71	0.73	0.15	0.05	0.04	0.03	0.03	0.03	0.03	0.03
	range	54–70	76–93	14–18	17.1–18.1	8.35–9.0	4.85–5.35	4.6–4.9	3.75–4.2	7.25–7.75	7.3–7.65
	N	37	34	37	33	22	24	12	23	23	12
Burma	mean	59.4	88.9	15.6	17.49	8.66	5.04	–	4.03	7.39	–
	±SEm	1.26	0.70	0.14	0.06	0.06	0.04	–	0.03	0.06	–
	range	48–73	79–101	13.5–17	16.85–18.55	8.45–9.0	4.9–5.2	–	3.9–4.15	7.2–7.8	–
	N	49	48	48	43	9	9	–	9	9	–
Vietnam (N=1)		–	–	–	17.6	8.5	5.5	4.9	4.1	7.85	7.55

caudatus. *Soriculus leucops* was also listed as a synonym of *caudatus* by Blanford (1888), but it is reasonably certain from the measurements he cites that the specimens were the larger, longer-tailed *leucops*, and not *caudatus*.

Soriculus leucops (incl. *baileyi*) is sympatric with *S. macrurus* (incl. *irene*) over a large area extending from central Nepal to southern China, northern Burma and northern Vietnam (Figs. 1b, 2a). Abe (1971, 1982) reported that *S. leucops* (which he called *S. baileyi*) was trapped in wet grass and shrubs, and fed on earthworms, whereas *S. macrurus* (which he called *S. leucops*) was caught in rhododendron forest, and ate insects. *S. leucops* is, in size, relative tail length, and dentition, generally primitive, but shows some specialization towards fossoriality (Abe 1982), though not to the degree exhibited by *S. nigrescens*.

Soriculus baileyi was described by Thomas (1914) from a single specimen, a skin and toothrows only taken in the Mishmi Hills, Assam, India. Subsequent collectors referred specimens from Vietnam and Nepal to *baileyi* (Osgood 1932, Abe 1971). Ellerman and Morrison-Scott (1951) placed *baileyi* as a subspecies of *S. caudatus*, but Abe (1971, 1982) pointed out that the two are morphologically distinct and sympatric in Nepal. I have examined other specimens from Burma and Nepal reported under the name *caudatus* (Anthony 1941, Mitchell 1977) and some of these also belong to the larger species (Table 2). I therefore arrange *baileyi* as a subspecies of *leucops*, and assign to it specimens of *leucops* from Burma, south China, and north Vietnam.

Soriculus gruberi was described by Weigel (1969) on the basis of seven specimens collected from Solukhumbu District, northeastern Nepal. It is darker in colour than *S. macrurus* and larger than *S. caudatus*, both of which are geographically sympatric, and appears to be



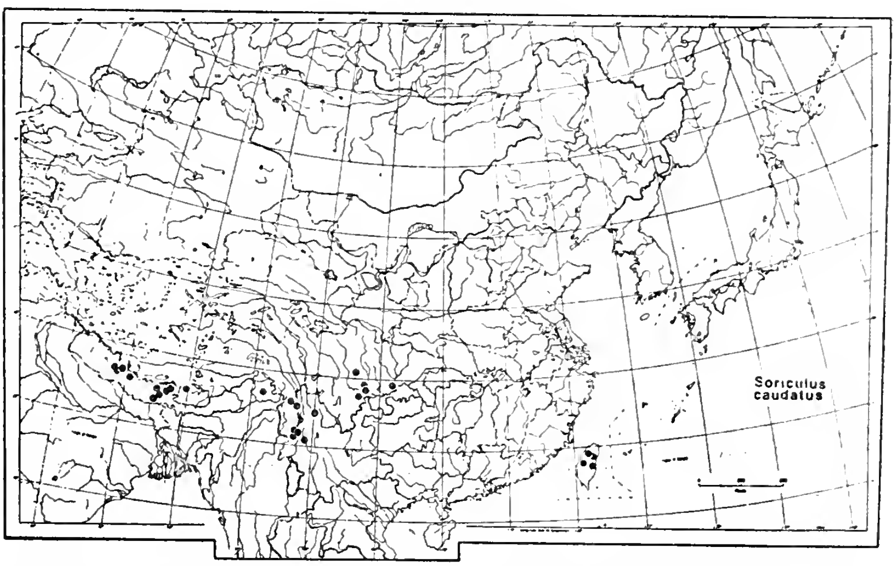


Fig. 2a (top). Distribution of *Soriculus macrurus.* Solid symbols, specimens examined; open symbols, literature records (Abe 1982, Mitchell 1977).

Fig. 2b (bottom). Distribution of *Soriculus caudatus* (mainland) and *S. fumidus* (Taiwan Island). Due to uncertainty concerning identification of literature records, only specimens examined are plotted.

a synonym of *S. l. leucops* (Abe 1977). Unfortunately, no specimens were seen, but the published measurements are close to those of *S. l. leucops* from Nepal.

Soriculus (Episoriculus) macrurus Blanford, 1888. Fauna Brit. India, 1, p. 231. Type locality: Darjeeling, India.

As noted in the account of *S. leucops* above, Osgood (1932), without comment, placed *macrurus* as a synonym of *leucops*, and was followed by subsequent authors. This led to confusion, since when *leucops* was applied to the smaller, very long-tailed taxon, the larger one was then named either *baileyi* or *caudatus*. This confusion is evident in Anthony's (1941) discussion (pp. 67-70) where he is impelled to employ the name combination *S. sacratus umbrinus* to accommodate the smaller *S. caudatus*, since he has assigned the larger *S. leucops baileyi* to *S. caudatus*, all because the name *S. leucops* was in use for *S. macrurus* (see also Cranbrook 1960-61). *Soriculus macrurus* is a shrew of moderate body and cranial dimensions, pale gray in dorsal pelage, and with a very long tail which always exceeds its head-body length (Table 3). The holotype (BMNH 90.1.1.19) has a tail more than $1\frac{1}{2}$ times as long as its body (Blanford 1888), and its skull is small (CIL 17.20 mm), with short, broad rostrum typical of *macrurus* (Fig. 3a; see below). Blanford (op. cit.) quoted measurements of two other specimens that clearly refer to this species. Its range extends from central Nepal eastward through western and southern China to northern Burma and Vietnam (Fig. 2a), and as noted above, it is broadly sympatric with both *S. leucops* and *S. caudatus*. *Soriculus irene* was described by Thomas (1911b) from Yuanching Hsien, near Emei-shan, southwest Sichuan. Earlier that year (1911a) he had assigned a specimen from Emei-shan to *S. macrurus* with the comment that it "agrees closely with Blanford's type from Darjeeling." Subsequent, Thomas (1921) doubted whether *irene* was distinct, and Allen (1938) formally arranged it as a synonym of *macrurus*.

Soriculus macrurus is a forest-dweller (Abe 1982, Mitchell 1977, as *leucops*) and its long tail and relatively large hind feet suggest that it may be at least partly arboreal. Abe (op. cit.) also suggested that *macrurus* (which he called *leucops*) might be altitudinally segregated from *leucops* (which he called *baileyi*), but at several localities in Nepal, southern China, and northern Burma (vic. Num; Gangfang, Adung Valley, Hpare-Saulang road) both species occur, and they overlap broadly in altitude, judging from the specimens I have examined.

Soriculus (Episoriculus) caudatus Horsfield, 1851. Cat. Mammals Mus. East India Co., p. 135. Type locality: Darjeeling, India.

The cotype from Sikkim and lectotype from Nepal consist of skins without measurements, plus rostra only. The holotype designated by Horsfield may be lost. This species is close to *S. macrurus* (with which it is widely sympatric) in skull and body size, but the tail is shorter, being equal to or less than head-body length (Table 4). The skull of *caudatus* may be distinguished from that of *macrurus* in that its rostrum is longer and more slender, and the upper unicuspids, especially the second, are longer than wide; the braincase and interorbital region are also relatively narrow (Fig. 3b). In *S. macrurus* the rostrum is short and broad, and the upper unicuspids are quadrate to wider than long (Fig. 3a). This species is less specialized morphologically than either *leucops* or *macrurus*, and is also more widespread and common. It occurs from Kashmir

TABLE 4

EXTERNAL AND SELECTED CRANIAL MEASUREMENTS *of Soriculus caudatus* AND *S. fumidus*

		Head-Body	Tail	Hind Foot	CIL	CB	MB	M^2-M^2	IOB	PIL	UTRL
S. s. caudatus											
Kashmir	(N=2)	68,74	49,54	15,16	18.05	9.2	5.3	5.05	4.15	7.7	7.45
Nepal	mean	61.2	54.1	13.0	17.96	8.80	5.03	4.63	3.82	7.91	7.69
	±SEm	0.64	0.62	0.18	0.12	0.13	0.05	0.04	0.04	0.10	0.07
	range	52–70	46–65	10–16	16.75–18.75	7.95–9.25	4.7–5.3	4.4–4.8	3.65–4.05	7.3–8.25	7.35–7.95
	N	40	43	43	18	10	10	9	10	10	9
Darjeeling	(N=1)	66	55	19(?)	17.9	–	–	–	–	–	–
Bhutan	(N=1)	50	–	12.5	–	–	–	–	–	–	–
S. c. umbrinus											
Assam	(N=1)	56	56	13	17.56	–	–	–	–	–	–
Burma	mean	58.33	50.6	12.1	17.50	8.48	4.93	–	3.84	7.50	–
	±SEm	0.88	0.48	0.10	0.06	0.05	0.03	–	0.05	0.05	–
	range	44–74	42–58	10–14	16.8–18.5	8.15–8.75	4.8–5.1	–	3.4–4.0	7.2–7.85	–
	N	63	63	65	39	13	13		13	13	
Yunnan	mean	62.0	53.67	12.75	17.98	8.86	5.13	–	3.93	7.88	–
	±SEm	1.05	0.93	0.17	0.13	0.11	0.05	–	0.06	0.13	–
	range	58–69	50–58	12–13.5	17.5–18.5	8.65–9.1	5.0–5.2	–	3.75–4.0	7.7–8.25	–
	N	10	9	10	8	4	4		4	4	
S. c. sacratus											
Sichuan	mean	63.74	57.0	14.2	17.98	9.08	5.46	5.06	3.93	8.11	7.78
	±SEm	0.59	0.80	0.11	0.09	0.05	0.04	0.02	0.04	0.07	0.05
	range	58–74	48–69	13–16	17.1–18.4	9.0–9.2	5.35–5.7	5.0–5.15	3.75–4.05	7.8–8.45	7.5–8.0
	N	38	36	38	18	4	9	9	9	9	9
S. fumidus											
	mean	61.75	46.0	12.8	18.38	9.33	5.20	4.86	4.22	8.03	7.84
	±SEm	1.12	0.89	0.27	0.10	0.04	0.06	0.04	0.04	0.06	0.06
	range	53–71	37–52	11–14.5	17.8–18.95	9.2–9.5	4.95–5.4	4.6–5.05	4.1–4.5	7.75–8.3	7.45–8.0
	N	16	16	16	12	9	7	9	9	9	9

eastward to western and southern China, and northern Burma (Fig. 2b), but not, apparently, Vietnam. Hence it occurs sympatrically with both *macrurus* and *leucops*, but may occupy a broader range of habitats than either of those species (Abe 1982, Mitchell 1977).

Soriculus (Episoriculus) fumidus Thomas, 1913. Ann. Mag. Nat. Hist., 11: 216. Type locality: Mt. Arisan (= Alishan), 8,000 ft., Chiai Hsien, Taiwan.

This species is best regarded as an insular allospecies of the mainland *S. caudatus* (Fig.

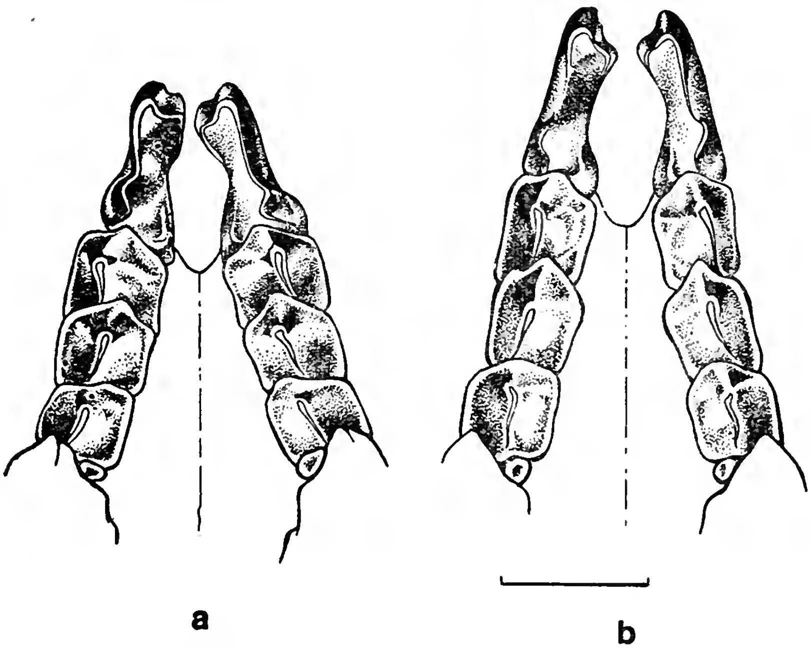


Fig. 3a (left). Skull of *Soriculus macrurus*, KU 138572, Pass between Dharpatan and Gurjakani, 15 km. W Dadar Dhuri Mts., Nepal.
Fig. 3b (right). Skull of *Soriculus caudatus*, KU 135571, Chowki, Nepal.

2b). It has been arranged as a subspecies of *caudatus* (cf. Ellerman and Morrison-Scott 1951), but its geographical isolation and morphological divergence (i.e., short, narrow rostrum, mandible with long angular and coronoid processes), support its recognition as a distinct species (Jameson and Jones 1977). It is also larger than *S. caudatus*, with a relatively shorter tail (Table 4). Thomas (1913) named at the same time, on the basis of a single skull from the same type locality *Chodsi-*

Thomas (1911) described *S. sacratus* as "a small species allied to *S. caudatus.*" The type series was from Emei-shan, Sichuan. Allen (1923) considered *sacratus* a subspecies of *caudatus*, and described a third subspecies, *S. c. umbrinus*, from Mucheng, southern Yunnan, as being a darker race. However, body and cranial size are similar in most of the samples I have examined (Table 4), and the subspecies are, at best, weakly characterized.

TABLE 5

EXTERNAL AND SELECTED CRANIAL MEASUREMENTS OF *Soriculus hypsibius* AND *S. lamula*

		Head-Body	Tail	Hind Foot	CIL	CB	MB	M^2-M^2	IOB	PIL	UTRL
S. hypsibius											
Sichuan,											
Tsao Po	mean	84.1	70.3	16.4	21.15	9.51	6.34	–	4.87	9.38	–
	±SEm	0.64	0.68	0.09	0.10	0.07	0.05	–	0.04	0.07	–
	range	77–95	62–80	15–18	19.65–22.0	8.95–10.15	5.9–6.7	–	4.6–5.2	8.85–10.05	–
	N	53	53	53	41	19	19		19	19	
Other											
Local.	mean	81.6	65.1	16.0	20.81	9.5	6.0	6.13	4.77	9.2	9.28
	±SEm	1.04	0.87	0.27	0.23	–	0.25	–	0.08	0.36	–
	range	73–99	60–71	15–18	19.85–22.1	9.1–9.9	5.6–6.45	6.0–6.25	4.6–4.85	8.5–9.65	9.2–9.35
	N	17	16	17	12	2	3	2	3	3	2
Shaanxi,	mean	–	–	–	20.45	–	–	–	–	–	–
	±SEm	–	–	–	0.15	–	–	–	–	–	–
	range	–	–	–	19.65–20.85	–	–	–	–	–	–
	N				7						
Yunnan	(N=1)	75	65	15	19.85	9.1	5.6	–	4.6	8.5	–
S. l. lamula											
Gansu	(N=1,2)	67	54	13	17.65,18.65	8.45, 8.5	5.0, 5.45	5.0, 5.35	4.1, 4.1	7.3, 7.8	7.15, 7.55
Sichuan	mean	72.0	61.6	15.2	18.41	8.24	5.23	5.25	4.13	7.84	7.4
	±SEm	1.25	1.94	0.31	0.17	0.15	0.08	–	0.07	0.10	–
	range	67–75	55–66	14–16	18.05–18.8	7.85–8.6	5.1–5.4	–	3.95–4.3	7.6–8.05	–
	N	6	5	6	4	4	4	1	4	4	1
S. l. parva											
Yunnan	mean	55.0	44.25	11.1	–	–	–	–	4.05	6.50	–
	±SEm	0.41	0.48	0.13	–	–	–	–			
	range	54–56	43–45	11–11.5	–	–	–	–			
	N	4	4	4					1	1	

goa sodalis. The holotype lacks fourth upper unicuspids, hence its (sub)generic allocation. Jameson and Jones (op. cit.) concluded that *sodalis* was a synonym of *fumidus*, based on an aberrant individual, and I concur. In a series of 19 *S. fumidus* that I examined, another specimen lacked upper fourth unicuspids, but was otherwise typical.

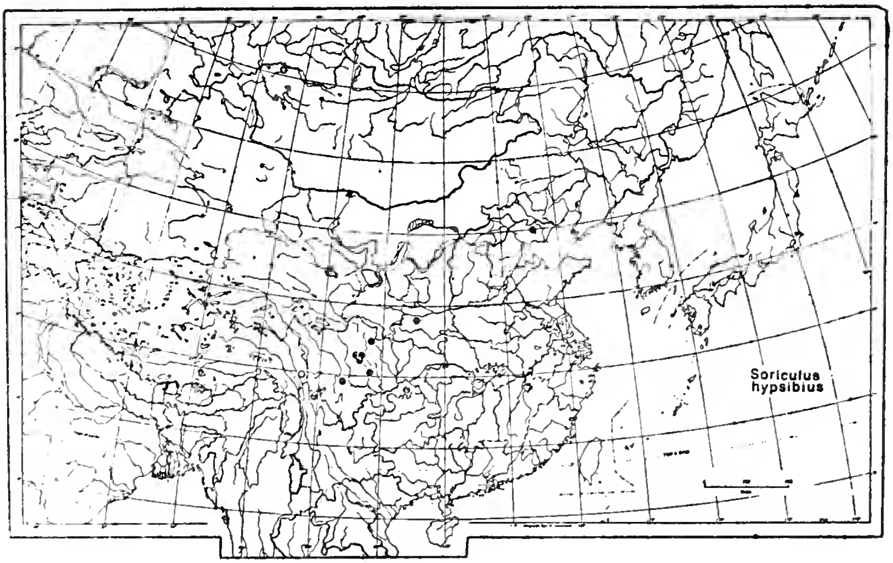
According to Jameson and Jones (op. cit.), *S. fumidus* is widely distributed in the temperate montane forests of Taiwan, and extends upward into the dwarf bamboo zone at 3,200 m. The ancestor of *fumidus* probably reached Taiwan during a glacial period, when temperate forests were more extensive in eastern China, and when the island was connected by a land bridge to the mainland.

Soriculus (Chodsigoa) hypsibius De Winton, 1899. Proc. Zool. Soc. London, 1899:574. Type locality: Yangliu-pa, Sichuan, China.

Chodsigoa was proposed as a genus by Kastschenko (1907). It differs from *Soriculus* and *Episoriculus* in several derived characters, including loss of the fourth upper unicuspids; more concave posterior margin of P^4-M^2; longer, more slender and sharply hooked anterior tine of I^1, with posterior tine relatively small, and more flattened braincase (Allen 1938, Repenning 1967). *Soriculus hypsibius* is in external dimensions only slightly larger than *S. caudatus*, with a tail no longer, and usually shorter than, the head and body. Cranially, however, it averages larger (Table 5), and is close to *leucops*. The ecological relationships of this species with *S. caudatus* would likely be of interest, given their similar body sizes and proportions, but they are not known. *Soriculus hypsibius* appears not to occur at localities where *caudatus* is found, but this needs verification; its range also extends eastward from the area of potential sympatry in Sichuan to include the Qin (=Tsing) Ling Shan in Shaanxi (Fig. 4a). Moreover, a disjunct population, named by Thomas (1911b) *C. larvarum*, is known from Hebei. The few specimens available are morphologically similar to nominate *hypsibius*, and it probably occurs more widely in northeastern China; I regard *larvarum* as a synonym of *hypsibius*. Two other taxa have also been described which are usually placed as subspecies, *S. h. lamula* and *S. h. parva* (cf. Corbet 1978), but these names are applicable to a smaller species (see below).

Soriculus (Chodsigoa) lamula Thomas, 1912. Ann. Mag. Nat. Hist., 10: 399. Type locality: 40 m SE Taochou, 9,500 ft., Gansu, China.

When Thomas described this species, he noted that it was "allied to *C. hypsibia*, but smaller." Since the name was based on a single specimen, it was reasonable for Allen (1938) to arrange *lamula* as a subspecies of *hypsibius*, and he has been followed by other workers (Ellerman and Morrison-Scott 1951, Corbet 1978). However, both small *S. lamula* and large *S. hypsibius* occur in a sample from Tsao Po, 15 mi SW Wenchuan, Sichuan, and it is evident from the distribution of other specimens that *S. lamula* is sympatric with *S. hypsibius* over a considerable area of Sichuan (Fig. 4b). In Yunnan the representative of this smaller species was originally named *Chodsigoa hypsibia parva* by Allen (1923), but he subsequently decided it was a distinct species, *C. parva* (Allen 1938). However, Ellerman and Morrison-Scott (1951) and Corbet (1978) continued to regard *parva* as a subspecies of *hypsibius*, even though Wang *et al.* (1966) pointed out that *parva* and *hypsibius* both occurred "in southwestern Szechwan [Sichuan] and northwestern Yunnan without any signs of hybridization. . . . ." Those authors did not,



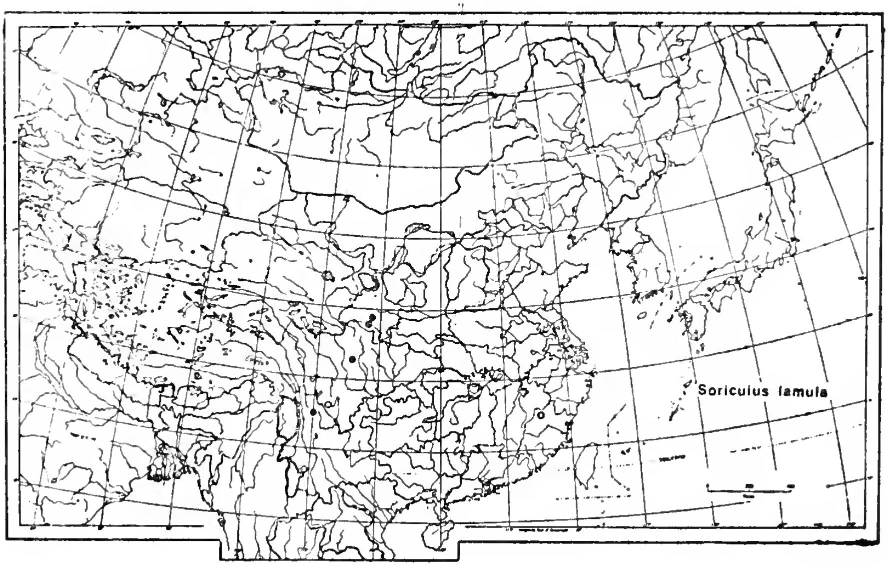


Fig. 4a (top). Distribution of *Soriculus hypsibius.* Solid symbols, specimens examined; open symbol, literature record (Feng *et al.* 1980).

Fig. 4b (bottom). Distribution of *Soriculus lamula.* Solid symbols, specimens examined; open symbols, literature records (Lehmann 1955, Lu *et al.* 1965, Wang *et al.* 1966).

TABLE 6

EXTERNAL AND SELECTED CRANIAL MEASUREMENTS OF *Soriculus salenskii*, *S. smithii*, AND *S. parca*

		Head-Body	Tail	Hind Foot	CIL	CB	MB	M^2-M^2	IOB	PIL	UTRL
S. salenskii											
Holotype*		81(78)	116(110)	23.5(22)	25	10					
S. smithii											
Siehuan	mean	81.1	97.5	18.0	22.06	9.84	6.14	6.02	5.05	9.86	9.75
	±SEm	2.00	1.51	0.30	0.20	0.13	0.15	0.05	0.02	0.09	0.13
	range	72–96	92–108	16–19	21.1–23.3	9.4–10.85	5.95–6.75	5.85–6.4	5.0–5.15	9.6–10.6	9.5–10.1
	N	13	11	13	10	10	5	10	10	10	4
Shaanxi	(N=2)	80, 82	83, 84	18, 18	22.2, 22.65	9.65, 9.9	6.35, 6.2	–, 6.15	5.15, 4.85	0.7, 10.05	–, 9.75
S. p. parca											
China	mean	70.0	82.9	17.0	19.43	9.18	5.63	5.22	4.55	8.43	8.27
	±SEm	0.98	3.12	0.48	0.22	0.14	0.09	0.10	0.15	0.11	0.12
	range	66–74	74–95	15.5–19	18.9–20.25	8.8–9.5	5.3–5.8	5.05–5.4	4.05–4.9	8.1–8.6	8.05–8.45
	N	7	7	7	5	5	5	3	5	5	
S. p. lowei											
Vietnam,	mean	72.6	90.2	16.2	19.98	9.53	5.67	5.41	4.6	8.88	8.55
Thailand	±SEm	1.63	1.80	0.37	0.15	0.13	0.11	0.05	0.08	0.08	0.08
	range	68–77	86–96	15–17	19.65–20.4	9.2–9.75	5.45–5.8	5.35–5.55	4.45–4.8	8.75–9.1	8.45–8.8
	N	5	5	5	5	4	3	4	4	4	4
S. p. furva											
Burma	mean	75.0	92.25	18.88	20.6	9.42	5.97	–	4.77	9.16	–
	±SEm	2.06	2.79	0.30	0.13	0.08	0.08	–	0.09	0.11	–
	range	68–84	80–108	18–20	20.4–20.9	9.2–9.7	5.8–6.25	–	4.5–5.0	8.85–9.55	–
	N	8	8	8	5	5	5		5	5	

* measurements from Allen, 1938 (my measurements of holotype).

however, discuss the relationship of *parva* to *lamula*. The two taxa are allopatric, and *parva* is smaller (Table 5) and darker than *lamula*, but these differences are not great (external measurements as reported are very small, but these are sometimes unreliable; the few cranial measurements are close to those of *lamula*). Lehmann (1955) reported one specimen of *parva* from Fujian. Given the few specimens available, it seems best to consider *parva* a subspecies of *lamula*.

The ecological relations of *S. lamula* to *S. hypsibius* and *S. caudatus* are unknown. The latter species was not taken at the place in Sichuan where the other two occurred, but *lamula* and *caudatus* both occur in the Lichiang Range, Yunnan, where *hypsibius* is not known.

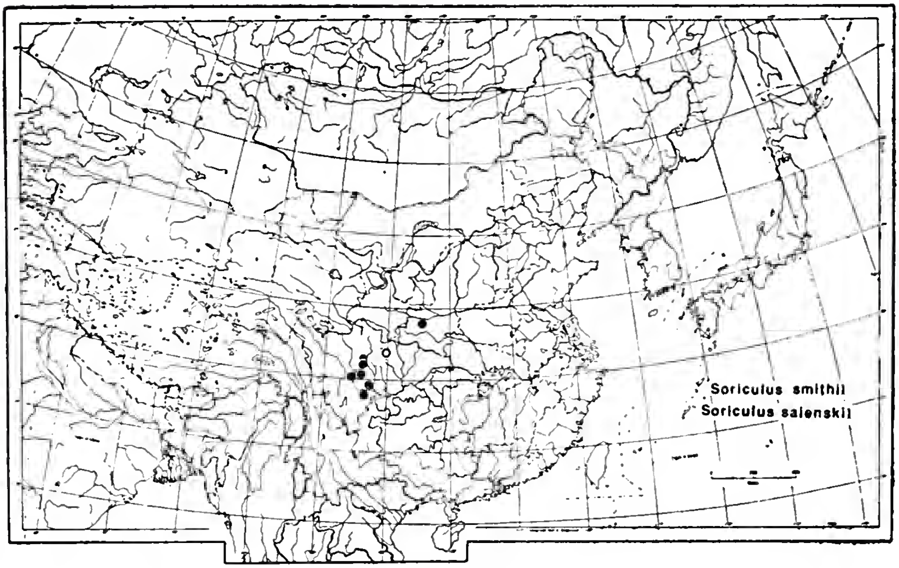
Soriculus (Chodsigoa) salenskii Kastschenko, 1907, Ann. Mus. Zool. Akad. Sci. St. Petersburg, 10: 253. Type locality: Kho-tszi-gou, Lun-ngan-fu (Linganfu), Sichuan, China.

This species is known only from the holotype, which I have examined. It was taken by Berezovskii in autumn, 1893, at Lun-ngan-fu (transliterated from Russian). Allen (1938) gave the type locality as "Linganfu, northern Szechwan." Pingwu, in northern Sichuan, was formerly called Lunganfu, and is probably the type locality. Although Ellerman and Morrison-Scott (1951) regarded *salenskii* as a senior synonym of *smithii* (incl. *furva* and *parca*), Corbet (1978) opined that *smithii* was "... most unlikely to be conspecific with *S. salenskii*...." This appears to have been based on size difference (Table 6); if the original measurements given by Kastschenko (see Allen 1938) are accurate, *salenskii* is indeed unusually large, especially in cranial and hind foot length. The holotype consists of a fluid-preserved adult specimen from which the skull has been removed. The original label bears the collecting locality, date, collector's name and field number, but no measurements, which were presumably made by the describer. External measurements which I made on the holotype were somewhat smaller than those reported by Kastchenko (Table 6, values in parentheses), and are within or close to the range of values for head-body and tail length in *S. smithii* from Sichuan, although the hind foot of the holotype is unusually large. Unfortunately, the skull of the holotype is missing, and a notation on the specimen label, apparently in A. A. Gureev's hand reads (in Russian) "no skull ?". Until more specimens are available, I retain *salenskii* as a monotypic species restricted to northern Sichuan (Fig. 5a), but I strongly suspect that it will prove to be conspecific with *S. smithii*.

Soriculus (Chodsigoa) smithii Thomas, 1911. Abstr. Proc. Zool. Soc. London, 90:4. Type locality: Tatsienlu, Sichuan, China.

This is also a large, long-tailed representative of the subgenus *Chodsigoa*, but it is somewhat better known, with a wider distribution than *S. salenskii*. It is somewhat larger in skull and body size than *S. hypsibius*, but with a much longer tail (Table 6), thus paralleling the difference between *S. macrurus* and *S. caudatus*. It is tempting to suppose that *smithii* represents the arboreal portion of the moiety, but nothing is known of its ecology. It occurs from central Sichuan to western Shaanxi (Fig. 5a).

The forms *S. s. parca* (Allen 1923) and *S. s. furva* (Anthony 1941) were both described as subspecies of *smithii* from Yunnan and northern Burma respectively, being smaller. Additional material reveals that they instead represent a distinct species (see below).



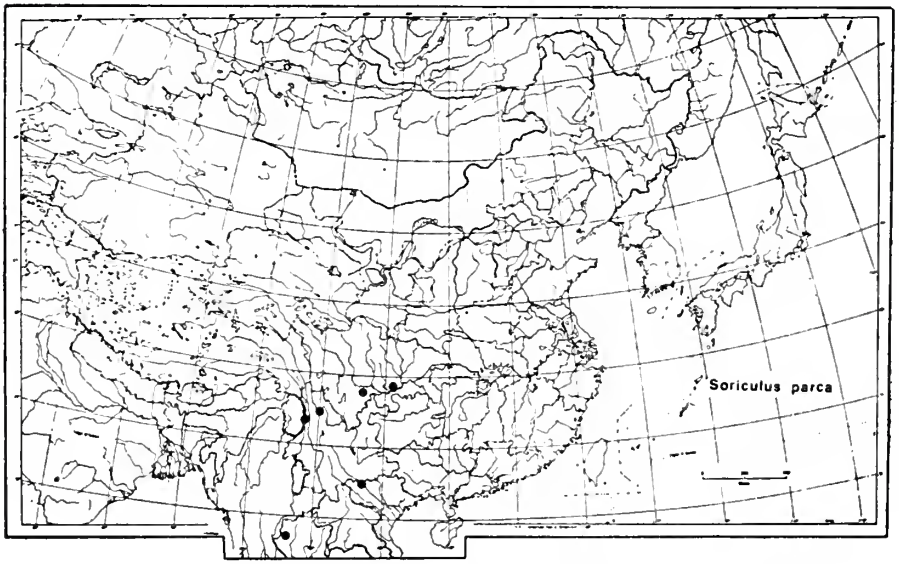


Fig. 5a (top). Distribution of *Soriculus smithii* (solid symbols) and *S. salenskii* (open symbol).

Fig. 5b (bottom). Distribution of *Soriculus parca*.

Soriculus (Chodsigoa) parca Allen, 1923. Amer. Mus. Novitates, No. 100: 6. Type locality: Homushu Pass, Yunnan, China.

While describing *parca* as a race of *smithii*, Allen (1938) nevertheless pointed out that it was much smaller than *smithii*, with "...the rostrum relatively shorter and more gradually tapering from braincase to tip instead of being abruptly narrowed in the premaxillary region." (Figs. 6a, b) (Table 6). Specimens from Ta Cho Fu, Sichuan, represent both *smithii* and *parca*, and the distribution of other records (Figs. 5a, b) indicates probable parapatry between the two species. Moreover, both *furva* and another form named *S.* (*C.*) *lowei* Osgood, 1932, appear to be closer to *parca* than to *smithii*, though they are somewhat larger in size than *parca*. These forms from

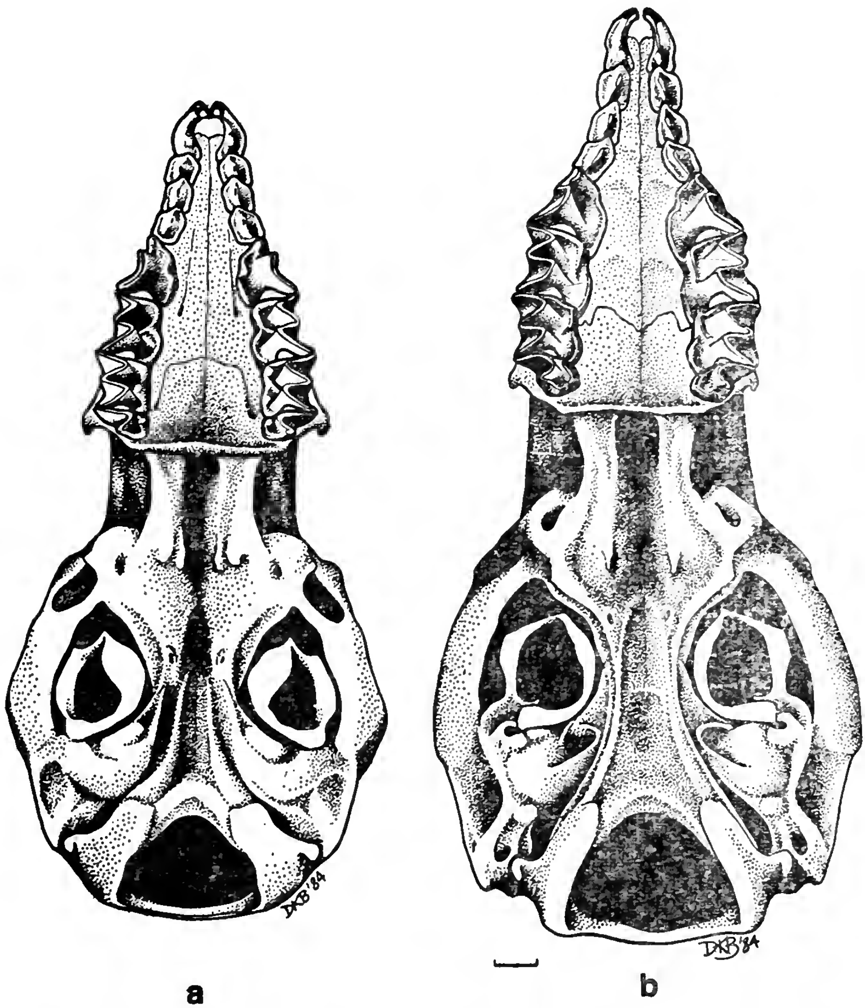


Fig. 6a (left). Skull of *Soriculus parca*, FMNH 39622, Ta Cho Fu, Sichuan, China.
Fig. 6b (right). Skull of *Soriculus smithii*, FMNH 39614, Ta Cho Fu, Sichuan, China.

northern Burma, Thailand (reported as *S. salenskii parca* by Lekagul and McNeely 1977), and Vietnam (Fig. 5b) are south of the range of *hypsibius* as well as *smithii*, and their increased size may be related to the nature of interspecific interactions among congeners inhabiting this area. I therefore place *furva* and *lowei* as subspecies of *S. parca.*

Discussion

Species distributions in the genus *Soriculus* fall into two broad groups — Himalayan and Chinese. The Himalayan group includes the three species of the subgenus *Episoriculus*, and *S.* (*Soriculus*) *nigrescens.* The Chinese group includes the members of the subgenus *Chodsigoa.*

Among the Chinese group, *S. hypsibius* has the largest, more northern distribution, *S. lamula* and *S. smithii* are mainly western, while *S. carpa* is southern, extending as far as northern Thailand and Vietnam.

Soriculus caudatus has the broadest distribution of the Himalayan forms, from Kashmir to central Sichuan, and thus penetrates eastward well into the range of the Chinese *Chodsigoa* species. However it is not known south of central Yunnan. *Soriculus macrurus* does not range so far west, but eastward extends to central Siehuan (with *caudatus*), and also southward to southern Yunnan and northern Vietnam. The range of *leucops* is more restricted, from central Nepal east and south to northern Vietnam.

The two groups meet in the mountains of northeastern Burma and adjacent Yunnan. Greatest species richness occurs around Gangfang, where five *Soriculus* are geographically sympatric — *S.* (*S.*) *nigrescens*, *S.* (*E.*) *leucops*, *S.* (*E.*) *macrurus*, *S.* (*E.*) *caudatus*, and *S.* (*C.*) *parca.* This is comparable to the number of sympatric *Sorex* found in some places such as the Altai Mountains (Yudin *et al.* 1979).

Among the Chinese Chodsigoa shrews, maximum species richness was found at Tsao Po, Siehuan, where in addition to *S.* (*C.*) *hypsibius*, *S.* (*C.*) *lamula*, and *S.* (*C.*) *smithii*, *S.* (*E.*) *macrurus* also occurred. In each case of high species richness, all except one belonged to the same geographic group (Himalayan or Chinese), and the "outsider" was a medium-size, long-tailed species (*parca* or *macrurus*).

Within an area of geographic sympatry, altitudinal and habitat segregation may result in niche separation among the species. *Soriculus nigrescens* is the most fossorial species, followed by *leucops* and probably *hypsibius;* these latter two are completely allopatric, and similar in size. The most generalized species, morphologically, appear to be *S. caudatus* and *S. lamula,* both of which are smaller than *leucops/hypsibius.* Their ranges are mostly allopatric, but meet in northwestern Yunnan.

The remaining three species are long-tailed forest inhabitants, and are probably more arboreal or at least scansorial, than the previous species. As noted previously, *S. smithii* and *S. parca* overlap but little in distribution. *S. macrurus* occurs with one or the other at several localities, with no indication of altitudinal separation. However, it is smaller than either.

Abe (1982) thought that altitudinal segregation might account in part for niche segregation between sympatric *Soriculus* in Nepal. The records I have examined indicate that there is much overlap among the species in altitude. However, *S. leucops* does not extend as high as other congeners (to 8700 ft in Nepal and 9500 ft in Burma, compared to 11-12,000 ft. for *macrurus* and *caudatus*). Altitudinal records for other species are so

scarce that generalizations are unwarranted at this time.

KEY TO THE GENUS *Soriculus*

1. Four upper unicuspid teeth present (small fourth unicuspid missing in rare cases) (Fig. 3) . . . . . . 2.
1′. Three upper unicuspid teeth present; subgenus *Chodsigoa* (Fig. 6) . . . . 6.
2. Size large; head-body length more than 70, usually more than 80, but tail short, usually about half that of head-body; foreclaws and feet large; subgenus *Soriculus* . . . . *S.* (*S.*) *nigrescens*
2′. Tail longer, forefeet and claws not enlarged, subgenus *Episoriculus* . . . . 3.
3. Size large, condyloincisor length of skull usually more than 18.8 mm; tail length about equal to that of head-body or slightly longer . . . . *S.* (*E.*) *leucops*
3′. Size smaller, condyloincisor length of skull usually less than 18.8 mm (except on Taiwan); tail variable . . . . 4.
4. Tail much longer than head and body; upper unicuspid teeth quadrate to wider than long; rostrum broad (Fig. 3a) . . . . . *S.* (*E.*) *macrurus*
4′. Tail about equal to or shorter than head-body; upper unicuspid teeth longer than wide; rostrum slender (Fig. 3b) . . . . 5.
5. Ratio of maxillary breadth to palatoincisor length usually more than 0.65; found on mainland Asia . . . . *S.* (*E.*) *caudatus*
5′. Ratio of maxillary breadth to palatoincisor length usually less than 0.65; found on Taiwan island . . . . *S.* (*E.*) *fumidus*
6. Tail longer than head and body; hind foot larger, usually more than 17 . . . . 7.
6′. Tail shorter than head and body; hind foot smaller, usually less than 17 . . . . 9.
7. Size very large, condyloincisor length about 25 mm; tail length more than 110, hind foot more than 21 mm; northern Sichuan . . . . *S.* (*C.*) *salenskii*
7′. Size smaller . . . . 8.
8. Size medium; condyloincisor length 21.1 to 23.3; hind foot less than 21 mm; skull robust, flattened; rostrum long, abruptly narrowing anteriorly (Fig. 6b) . . . . *S.* (*C.*) *smithii*
8′. Size smaller; condyloincisor length 18.9-20.9; skull more lightly built, braincase not strongly flattened; rostrum short, gradually tapering anteriorly (Fig. 6a) . . . . *S.* (*C.*) *parca*
9. Size larger; condyloincisor length of skull more than 19.0 mm . . . . *S.* (*C.*) *hypsibius*
9′. Size smaller; condyloincisor length of skull less than 19.0 mm . . . . *S.* (*C.*) *lamula*

SYSTEMATIC SUMMARY

Genus *Soriculus* Blyth, 1854.

Subgenus *Soriculus*. Type species, *Corsira nigricans* Gray, 1842.

Soriculus nigricans nigricans Gray 1842. Type locality, Darjeeling, West Bengal, India. Synonyms: *aterrimus* Blyth, 1854; *caurinus* Hinton, 1922; *centralis* Hinton, 1922; *holoscriceus* Gray, 1863 (nomen nudum); *oligurus* Gray, 1863 (nomen nudum); *pahari* Hinton, 1922; *sikimensis* Hodgson, 1855.

Soriculus nigrescens radulus Thomas, 1922. Type locality, Dreyi, Mishmi Hills, 5140 ft., Assam, India.

Subgenus *Episoriculus* Ellerman and Morrison-Scott, 1951. Type species, *Sorex caudatus* Horsfield, 1851.

Soriculus caudatus caudatus Horsfield, 1851. Type locality, Darjeeling, West Bengal, India. Synonyms: *gracilicauda* Anderson, 1877; *homourus* Gray, 1863 (nomen nudum); *soluensis* Gruber, 1969.

Soriculus caudatus sacratus Thomas, 1911. Type locality, Emei Shan, 6000 ft., Yuen-ching Hsien, Sichuan, China.

Soriculus caudatus umbrinus G. Allen, 1923. Type locality, Mu-cheng, Salween drainage, 7000 ft., Yunnan, China.

Soriculus fumidus Thomas, 1913. Type locality, Mt. Arisan, 8000 ft., Chiai Hsien, Taiwan. Synonym: *Chodsigoa sodalis* Thomas, 1913.

Soriculus leucops leucops Horsfield, 1855. Type locality, Nepal. Synonyms: *gruberi* Weigel, 1969; *minor* Dobson, 1890; *nivicola* Gray, 1863 (nomen nudum).

Soriculus leucops baileyi Thomas, 1914. Type locality, Mishmi Hills, Assam India.

Soriculus macrurus Blanford, 1888. Type locality, Darjeeling, West Bengal, India. Synonym: *irene* Thomas, 1911b.

Subgenus *Chodsigoa* Kastschenko, 1907. Type species, *Soriculus hypsibius* de Winton, 1899.

Soriculus hypsibius de Winton, 1899. Type locality, Yang-liu-pa, Sichuan, China. Synonyms: *berezowski* Kastschenko, 1907; *larvarum* Thomas, 1911b.

Soriculus lamula lamula Thomas, 1912. Type locality, 40 mi SE Taochou (Lintan), 9500 ft., Gansu, China.

Soriculus lamula parva G. Allen, 1923. Type locality, Ssu Shan (Xue Shan) Chang, Likiang Range, 9000 ft., Yunnan, China.

Soriculus salenskii Kastschenko, 1907. Type locality, Lun-ngan-fu, Sichuan, China.

Soriculus smithii Thomas, 1911. Type locality, Tatsienlu (Kangting, Dardo), 9000 ft. Sichuan, China.

Soriculus parca parca G. Allen, 1923. Type locality, Ho-mu-shu Pass, 8000 ft., Yunnan, China.

Soriculus parca lowei Osgood, 1932. Type locality, Chapa, Tonkin, Vietnam.

Soriculus parca furva Anthony, 1941. Type locality, [Mt.] Imaw Bum, Kachin Prov., Burma.

Specimens Examined:

Abbreviations: AMNH, American Museum of Natural History, New York; BMNH, British Museum (Natural History), London; FMNH, Field Museum of Natural History, Chicago; KU, Museum of Natural History, University of Kansas, Lawrence; MCZ, Museum of Comparative Zoology, Harvard University, Cambridge; USNM, National Museum of Natural History, Washington; ZIN, Zoological Institute, Academy of Sciences, Leningrad.

Soriculus n. nigrescens. INDIA, West Bengal, vic. Darjeeling. (BMNH) 42.4.29.65 [holotype]; 43.5.31.5); Darjeeling Dist., Ghoom (Ghum), 4 (FMNH 82565 through 68); Sandikphu (Sandakaphu), 1 (MCZ 57022); N. P., Kumaon, Dhakuri, 2 (BMNH 14.7.10.245 [holotype *caurinus*], FMNH 8257); Sikkim, Gnatong (Gnateng), 5 (BMNH 15.9.1.56 [holotype, *pahari*], FMNH 82561 through —64; Lingtam (Lingbom), 1 (FMNH 35411). NEPAL, Bouzini, 3 (BMNH 22.5.16.17 [holotype, *centralis*], FMNH 82569, —70); Sukapatal, 1 (KU 135572); Zom Khola, Kung Chu (Kuncha) 6 (AMNH 24044 through —49). *Soriculus nigrescens radulus.* INDIA, Assam, Mishmi Hills, Dreyi (Dri River), 1 (BMNH 21.12.5.6. [holotype]); CHINA, Yunnan, Gangfang, 1 (AMNH 114655).

Soriculus l. leucops. NEPAL, no exact locality, 1 (BMNH 79.11.21.483 [holotype]); Mayangdi Khola (River), Tazumsi-brang, 1 (KU 138568); Sankhuwasabha Khola, vic. Num, 27°40′N, 87°16′E, 2 (FMNH 114147, 114204). INDIA, Sikkim, Lingtam (Lingbom), 3 (FMNH 35414, —15, —16). *Soriculus leucops baileyi.* INDIA, Assam, Mishmi Hills, Tsu River, 1 (BMNH 14.1.1.1. [holotype]). BURMA, Kachin Prov., Adung Valley, 1 (FMNH 40935); Hpimaw, 1 (AMNH 114791); Hpare, 2 (AMNH 114795, —97); Hpare Pass, 2 (AMNH 114798, —99); Hpare-Saulang road, 3 (AMNH 114705, 114794, 114796); Htawgaw, 3 (AMNH 114769, —70, —71); Hkamkawn, 1 (AMNH 114793); Hpinlaw Kha (River), 2 (AMNH 114637, 114807); Black Rock, 1 (AMNH 114792); Tangtung, 4 (AMNH 114658, 114660, 114722, —73). CHINA, Yunnan, Gangfang, 17 (AMNH 114619; 114774 through —87, —89, 114863; Liang Shan, 1 (AMNH 111328). VIETNAM, Tonkin, Lo-Qui-Ho, Mt. Fan Si Pan, 8 (BMNH 33.4.1.197, —198, —199; FMNH 39031 through —36).

Soriculus macrurus. INDIA, West Bengal, Darjeeling Dist., vic. Darjeeling, 1 (BMNH 90.1.1.19 [holotype]); Sikkim, Chungtang (Chungthang), 1 (BMNH 15.9.1.81). NEPAL, Trisuli Valley, Nuwakot Khola, 2 km S. Dunche, 1 (KU 138567); Dar Khola, W of Dadar Dhuri Mt., 2 (KU 138570, —71); Pass between Dharpatan and Gurjakani, 15 km W Dadar Dhuri Mts., 1 (KU 138572). Palpa Dist., Dara (Dar) Khola, Lumsum, 2 (BMNH 75.106, —07); 5 mi E Jammagoan (Jamuna), 1 (FMNH 94151); Sankhuwashabha Khola, vic. Num, 27°40′N, 87°16′E, 2 (FMNH 114137, —50); Mangalbare, 2 (USNM 290034, —35). CHINA, Sichuan, near Omi-san (Emei Shan), Yuen-ching Hsien, 2 (BMNH 11.9.8.21, —22 [holotype, *irene*]); Tsao Po, 15 mi SW Wenchwan (Wenchuan), 2 (AMNH 111088, —89); Chengou Forks, 30 mi W. Wenchwan, 2 (AMNH 111108, —10); Omi-san (Emei Shan), 2 (BMNH 11.2.1.47, —48); Gan Yang Go 4 (FMNH 36200 through —03); Dun Shi Go, 5 (FMNH 36241, —42, —44 through —46); Lu Ting (Luding) Shan, 2 (FMNH 36204, —05); Lu Erh Cheh, 2 (FMNH 39624; USNM 260750); Mouping (Pao-hsing, Baoxing), 7 (FMNH 36238, —47, —48, —51 through —53; USNM 260749); no exact locality, 1 (KU 11685); Yunnan, 20 mi N Taku (T'a-K'o), Ha-Pa, 1 (MCZ 20726); La-chu-mi, 1 (AMNH 44451); Mekong River, Hsiao-ki-la, 1 (AMNH 44375); Chung-lu (Chung-lo), 1 (FMNH 35750); Salween drainage, Mu-cheng, 2 (AMNH 44469; MCZ 20728); Salween-Irawaddy divide, 1 (BMNH 23.3.7.5); To-mulang, 1 (AMNH 44415); 20 mi S Chungtien (Zhongdian), Tu-Gan-Sha, 1 (MCZ 20727); Gangfang, 9 (AMNH 114608 through —14, —18, —56); no

exact locality, 3 (AMNH 57195, —97, —98). BURMA, Kachin Prov., Adung Valley, 1 (BMNH 32.11.1.34); road to Chimeli Pass, 3 (AMNH 114631 through —33); Hpare-Saulang road, 14 (AMNH 114642 through —54, 115533, —51); Hpimaw road, 4 (AMNH 114638 through —41); Hpawti, 3 (AMNH 114630, —34, —35); Imaw Bum, 4 (BMNH 20.8. 7.3, —4; AMNH 114621, 114788); Nyetmaw River, 11 (AMNH 114622-29; 115558, 115560; 115564); Vijawlaw, 3 (AMNH 114615 through —17). VIETNAM, Tonkin, Lo-Qui-Ho, Mt. Fan Si Pan, 1 (FMNH 39030).

Soriculus c. caudatus. NEPAL, no exact locality, 1 (BMNH 79.11.21.479 [lectotype]; Zom Khola, Kung Chu (Kuncha), 1 (AMNH 240732); near Lamnag, 15 (AMNH 240728 through —43); Gorrcha Dist., NW of Apoon (Apun), 2 (FMNH 82572, —73); Nuwakot Dist., Phulung Ghyang, 3 (FMNH 104103, —05, —08); 3 mi above Biqu (Bique), 1 (FMNH 94145); 5 mi E Jammagoan (Jamuna), 1 (FMNH 94153); 27°40′N, 87°16′E, 4 (FMNH 114136, —38, —40, —51); Kasuna (Kasua) Khola, 1 (FMNH 114157), 27°38′N, 87°12′E, 3 (FMNH 114159 through —61); Balutar, 1 (FMNH 114164); Chitre, 1 (USNM 290036); Mangalbare, 9 (USNM 290037 through —45); Chowki, 1 (KU 135751). INDIA, Sikkim, no exact locality, 1 (BMNH 79.11. 21.480 [cotype]); Bhutan, Gasa, 1 (USNM 395250); West Bengal, Darjeeling Dist., Sandakphu, 1 (MCZ 57923); Kashmir, Khistwar Dist., Dachin, 2 (USNM 173916, —17). *Soriculus caudatus sacratus.* CHINA, Sichuan, Omi-san (Emei Shan), 6 (BMNH 11.2.1.49 through —54 [holotype]); Fi Shan Kwan (Fu Hsian Shan), 3 (FMNH 37206, —39, 39652); Pin Yang Goh, 4 (FMNH 45891 through —94); Lu Erh Cheh, 1 (USNM 260759); Shan Wan Kun (Shawan), 14 (FMNH 39635 through —38, —40, —43 through —50); Tao Cho Fu, 11 (FMNH 39625, —27, —28, —30 through —34, —41, —42). *Soriculus caudatus umbrinus.* CHINA, Yunnan, Salween drainage, Mucheng, 9 (AMNH 44334, —38 [holotype], —53, —55, —67; FMNH 35748, —49; MCZ 20735-36); Lichiang (Likiang, Lijiang) Range, 1 (BMNH 23.4.1.11); Gangfang, 4 (AMNH 114661, —62, 1147116, —53); Taron Valley, Kui-Kiang, 1 (BMNH 23.3.7.6). INDIA, Assam, Sienghku Wang, 1 (BMNH 27.3. 7.4). BURMA, Kachin Prov., Adung Valley, 17 (BMNH 32.11.1.36 through —44; FMNH 40928 through —34, —36); Changyinku, 5 (AMNH 114731, —32, —35 through —37; road to Chimeli Pass, 1 (AMNH 114683); Hpare, 9 (AMNH 114706 through —8, —30, —44 through —47, —50); Hpawti, 5 (AMNH 114691, —92, 114719-25, —59); Hpimaw, 5 (AMNH 114694 through —96, —98, 114729); Imaw Bum, 1 (AMNH 114672); Saulang 2 (AMNH 114659, 114738); Tantung, 2 (AMNH 114726, —28); above Tosnma, 2 (AMNH 114681, —82); Vijawlaw, 2 (AMNH 114715, —54).

Soriculus [caudatus] fumidus. CHINA, Taiwan, Chiai Hsien, Mt. Arizan (Ali-shan), 12 (BMNH 12.11.23.1 [holotype], —2 [holotype, *sodalis*]; USNM 322804 through —10; 358657 through — 59); 100 mi E Ali-shan Station (in error; as stated, in South China Sea), 1 (USNM 358108); Han (= Nan) Tou Hsien, Wu Sheh, Yin Feng, 4 (USNM 322802, —03, —11, —12); 20 mi NE Wu She (Sheh), 1 (BMNH 71.492); Chuei Feng, 2 (USNM 322800, —01).

Soriculus h. hypsibius. CHINA, Sichuan, Kho-tsi-gou, Lun-gnan-fu, 6 (ZIN 6436 [holotype, *berezowski*], 6430 through —33, —35); Chengou Creek, Chengwai, 25 mi W. Wenchwan (Wenchuan), 11 (AMNH 111090 through —92, —94 through —98, 111100, —02, —06); Tsao Po, 15 mi SW Wenchwan, 58 (AMNH 111011 through —21, —24, —24 through —27, —29 through —31, —33 through —36, —38 through —41, —44, —45, —47 through —50; 52 through —54, —56, —58 through —60, —62, —64 through —73, —75 through —77, —81, —83, —84, —86, —87); Sungpan (Songpan, Sungqu), 1 (FMNH 43866); Ta Tsai Tsu, 1 (FMNH 43842); Tze Mei, Minya Konka (Kungka) (Gongga Shan), 1 (AMNH 113533); Tank-ko (Tan Kuo), Chu Lung Shien (= Hsien ?), 1 (AMNH 113534); Weichou (Weizhou, Wenchuan), Si Ho (River), 2 (BMNH 11.9.8.2.3, —24); Yang-liu-pa, 1 (BMNH 99.3.1.10 [holotype]); Yunnan, Chungtien (Zhongdian) Dist., Song-pa (AMNH 4471); Shaanxi, Tsing Ling (Qin Ling) Shan, base of Tai Pei (Taibai) Shan, 21 (AMNH 56066, —67, —70 through —72, —76, —78, —79, —81 through —85), FMNH 35757-61); MCZ 20729 through —31). Hebei, 65 mi E Peking (Beijing). Eastern Tombs, 2 (BMNH 8.8. 7.20.-21 [holotype, *larvarum*]).

Soriculus l. lamula. CHINA, Kansu, 40 mi SE Taochou (Lintan), 1 (BMNH 12.8.5.22 [holotype]); Chone (Jone) Dist., 2 (AMNH 111069; MC 24117); Sichuan, Goan Shih Dwe, 1 (AMNH 111065); Tsao Po, 15 mi SE Wenchwan (Wenchuan), 5 (111028, —42, —61, —74, —79). *Soriculus lamula parva.*

Yunnan, Lichiang (Likiang, Lijiang) Range, Ssu Shan Chang (Xue Shan), 4 (AMNH 44390 [holotype], —91, —95; MCZ 20734).

Soriculus salenskii. CHINA, Sichuan, Lun-ngan-fu, Kho-tsi-gou, 1 (ZIN 6388 [holotype]).

Soriculus smithii. CHINA, Sichuan, Tatsienliu (Kangting, Kangding, Dardo), 1 (BMNH 11.2.1.55 [holotype]); Chengou Forks, 30 mi W Wenchwan (Wenchuan), 2 (AMNH 111009, —11); Chengou Creek, Chengwei, 25 mi W Wenchwan, 4 (AMNH 111103 through —05, —07); Tsao Po, 15 mi SW Wenchwan, 1 (AMNH 111032); Dun Shi Go, 1 (FMNH 37240); Lu Ting (Luding) Shan, 1 (FMNH 36199); Ta Cho Fu, 2 (FMNH 39614, —15); Yu Long Kong, 1 (FMNH 33284); Shaanxi, Tsing Ling (Qin Ling) Shan, base of Tai Pei (Taibei) Shan, 2 (AMNH 56088; MCZ 20732).

Soriculus parca parca. CHINA, Yunnan, Ho-mu-shu Pass, 2 (AMNH 44409 [holotype], 44376); Gangfang, 1 (AMNH 114664); Lichiang (Likiang, Lijiang) Range, Ssu Shan (Xue Shan), 2 (AMNH 44369; MCZ 20733); Sichuan, Ta Cho Fu, 2 (FMNH 39621, —22); "Kweichow" (Sichuan), Shuan Lung (Shuanglong) Chang, 1 (FMNH 39653; skin only, possibly *S. hypsibius*). BURMA, Imaw Bum, 1 (AMNH 114620 [holotype, *furva*]); Laukhaung, 1 (AMNH 114617); Pyepat, 1 (AMNH 114616); Rawngaw, 4 (AMNH 114636, 114800 through —02).

Soriculus parca lowei. VIETNAM, Tonkin, Chapa, 1 (BMNH 32.4.19.4 [holotype]); THAILAND, summit, Mt. Angka (Doi Angka), 4 (MCZ 35448 through —51).

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FUNCTIONAL ANATOMY OF THE EGG AND NYMPHAL MORPHOLOGY OF THE GRASS TINGID *AGRAMMA HUPEHANUM* (DRAKE & MAA) (HETEROPTERA: TINGIDAE) WITH A NOTE ON ITS EGG PARASITES[1]

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(*With two plates*)

The development and arrangement of body outgrowths are peculiar in the nymphal instars of *Agramma hupehanum* (Drake & Maa), a monophagous grass tingid. The spines that develop anteriorward from the 9th abdominal segment, have their full complements only in the 4th instar, but are significantly reduced to rudiments in the fifth instar. The wing pads that do not appear in the fourth instar develop fully in the fifth instar. The eggs are parasitised by a Trichogrammatid belonging to the genus *Lathromeromyia* Girault and a Mymarid, belonging to the genus *Parallelaptera* Enock.

Introduction

Our knowledge on the functional anatomy of the eggs and nymphal morphology of Tingidae has its beginning from the work of Roonwal (1952) on the exotic bug *Teleonemia scrupulosa* Stal. Since then, a few workers published brief reports on the biology and bionomics of a few indigenous species (Patel and Kulkarney 1955, Mathur 1955, Mathen 1960 and Asari 1972). Livingstone, 1959, 1967, 1976 & 1978 and Livingstone *et al.* 1981 added further information on the functional aspects of eggs and nymphal morphology of six more species of Tingidae. Tingid eggs and nymphs vary considerably in their functional morphology and anatomy and information on these aspects of grass tingids is not available in literature. Host plant records (Drake & Ruholf 1965) indicate that members of the subfamily Agrammatinae are pests of a wide variety of grasses. The systematic position of this subfamily still remains open for discussion. In the present paper, an account of the functional anatomy of the egg and the nymphal morphology of one species of grass tingid has been given.

Materials and Methods

Agramma hupehanum (Drake & Maa) is a monophagous species. Adults and nymphs were collected periodically from *Heteropogon fulcrus*, a very common grass of South India. Adults and nymphs exhibit strong geotaxic tendency and their coloration very appropriately matches with the soil on which the grass grows. Therefore, considerable effort is required to spot these insects, while searching an affected grass blade. Eggs were removed from the affected leaves directly and by treating them in 10% KOH and then in weak acetic acid. Before mounting them in polyvinyl lactophenol, they were dehydrated and cleared in

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cellosolve. Nymphs and eggs were also mounted directly in polyvinyl lactophenol, after treating them briefly in cellosolve. Parasitised eggs were collected directly from the seriously affected leaves and the emerging parasites from these eggs were mounted directly in polyvinyl lactophenol.

Taxonomic description of the adult

Agramma hupehanum was first reported from the Lichuan District, Western Hupeh, China by Drake and Maa on July 17, 1947. The host plant was not known then and the original description (Drake & Maa 1954) is quite inadequate and not illustrated. In order to include more characters, a redescription of the insect, with suitable illustrations (Plate I, Figs. 1 and 2), has been considered necessary. The present description applies to an adult male collected from Maruthamalai, a scrub jungle ecotone of Coimbatore district.

Minute in size. Length 2.16 mm and width across the prothorax 0.56 mm.

Head ferrugineous black, armed with only a pair of short testaceous clypeal tubercles; antennae moderately long, distinctly pilose and somewhat fuscous; antennal segments I and II fuscous, short stout and subequal in length; segment III uniformly elongate, fuscous and thrice as long as the fusiform, apically fuscous to brown segment IV; brown antenniferous tubercles very prominent; rostrum long, extending upto the middle of the mesosternal furrow; bucculae moderately expanded without areolae, almost concealing the first rostral segment. Pronotum slightly convex, coarsely punctate, with a median non areolate carina anteriorly extending a little beyond the pronotal hood and posteriorly terminating subapically on the prominently areolate, sharply pointed, stramineous, medially brown fuscous and laterally grading into black fuscous proscutellum.

Elytra stramineous brown, completely covering and extending beyond the abdomen; subcostal area narrow, almost entirely uniseriate except at the middle with 2-4 additional areolae; areolae moderately enlarged, subquadrate, transparently clear, gradually increasing in their size distally; radial area moderately broad, quadriseriate; discoidal area narrow at both ends and the areolae of the middle enlarged region 5-6 seriate; sutural area confluent with radial area, 5-6 seriate in the middle, areolae enlarged distally; hypocostal lamina (costa) uniseriate and moderately prominent; subcosta and radius alone beset with moderately long blunt hairs and rest of the elytra bare; legs short, slender; distitarsus bearing spatulate hairs ventrally; tibiae fringed with prominent setal combs.

Out of the 63 species of *Agramma* recorded all over the world, only three species have been reported from India (Drake & Ruhoff 1965). They include, *A. hupehanum*, from Bengal; *A. gibba* Fieber (*Serenthia gibba* Fieber, Distant 1904) from Eastern India and *A. scitulum* Drake & Maa from Tanjore District, S. India (Drake & Maa 1955).

Functional anatomy of the egg

A. hupehanum inserts its eggs singly, mostly parallel to each other, into the mesophyll, throughout the length of the midrib and lateral veins. Abaxial surface is preferred and the opposite surface of egg deposition site always reveals the egg as the epidermis transparently bulges out. The entire egg is buried into the leaf tissue, leaving only the operculum exposed. There is neither smearing of faecal matter around the operculum nor any cork formation around the egg, as often reported in the eggs of Tingidae (Johnson 1936 and Livingstone 1959).

The egg (Plate I, Fig. 3) is milky white, elongately oval and its surface that rests in the mesophyll distinctly convex. The shape of the egg is well suited for easy penetration into the thin lamina.

The egg is divisible into the body, the exochorionic collar and the operculum. The body of the egg is smooth, 0.403 ± 0.01 mm long and 0.196 ± 0.005 mm broad. The chorionic collar is short (0.019 ± 0.002 mm) and the operculum flushes well with the rim of the chorionic collar.

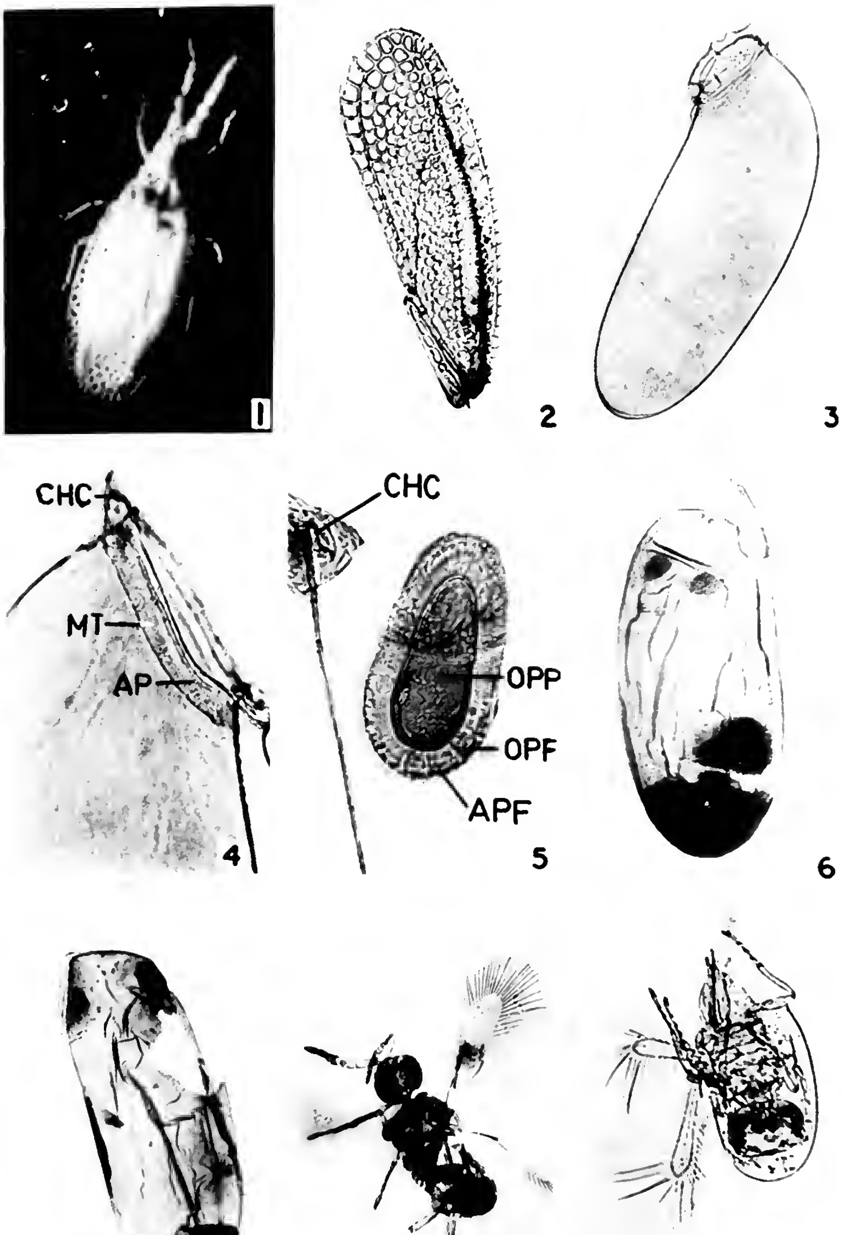
The exochorion is very thin (less than 0.0034 mm) and is closely invested by the thin endochorion which is visible at the mouth of the egg when the operculum is removed. When the egg swells, the endochorion lifts the operculum and projects beyond the rim of the exochorionic collar.

The *exochorionic collar* or the "chorionic rim collar" of Cobben (1964), extends beyond the mouth of the egg (PlateI, Fig. 4 CHC). The base of the collar on its inner surface is marked by the circular notch into which the posterior opercular flange snugly fits as the sealing bar, as reported by other workers (Beament 1946, Southwood 1956 and Livingstone 1962, 1967 & 1978). The chorionic collar is finely punctate and not profusely reticulate as it is reported so in several other species having more elongated collar (Cobben 1964, Livingstone 1976 & Livingstone *et al.* 1981). The rim of the collar reflects back upon itself slightly (Plate I, Fig. 5 CHC) all around. The inner surface of the collar develops 10-14 aeropyles (Plate I, Fig. 4 AP). These aeropyles are visible as canals upto a length of 0.016 ± 0.003 mm and beyond that they indistinguishably merge with the punctations of the collar rim and basally they open independently at the mouth of the egg. None of these canals branch as reported in *Leptobyrsa rhododendri* (Johnson 1936) and *Teleonemia scrupulosa* (Roonwal 1952) and there is no indication of any accessory aeropyles as reported in *Dasytingis rudis* (Livingstone 1976) and *Pontanus puerilis* (Livingstone *et al.* 1981). There is no trace of micropyles in *A. hupehanum* and none of the aeropyles reported here have any trace of direct opening to the exterior. However, in tingid eggs, Southwood (1956) and Stusak (1968) have considered all the aeropyles as true micropyles and Cobben (1964) concluded that tingid eggs possess two micropyles, besides many aeropyles.

The operculum (Plate I, Fig. 5) is broadly ovate and slightly convex exteriorly, It is composed of a central (OPP) more tough opercular plate (0.081 ± 0.002 mm diameter). From its rim, a membranous opercular flange (OPF) or the sealing bar, that is directed backward to the base of the çollar, snugly fits into the circular notch. The rim of the opercular plate further develops anteriorly a reticulate (spongy) flange (APF) bearing about 20 canals. This anterior flange remains opposed to the inner surface of the chorionic collar, extending upto the rim of the latter. This arrangement establishes an effective air filtering mechanism for the aeropyles. The number of the canals present on the opercular anterior flange is much more than the number of aeropyles. Structurally, the opercular apparatus resembles that of *Urentius euonymus* (Livingstone 1959) and of *Stephanitis typica* (Mathen 1960).

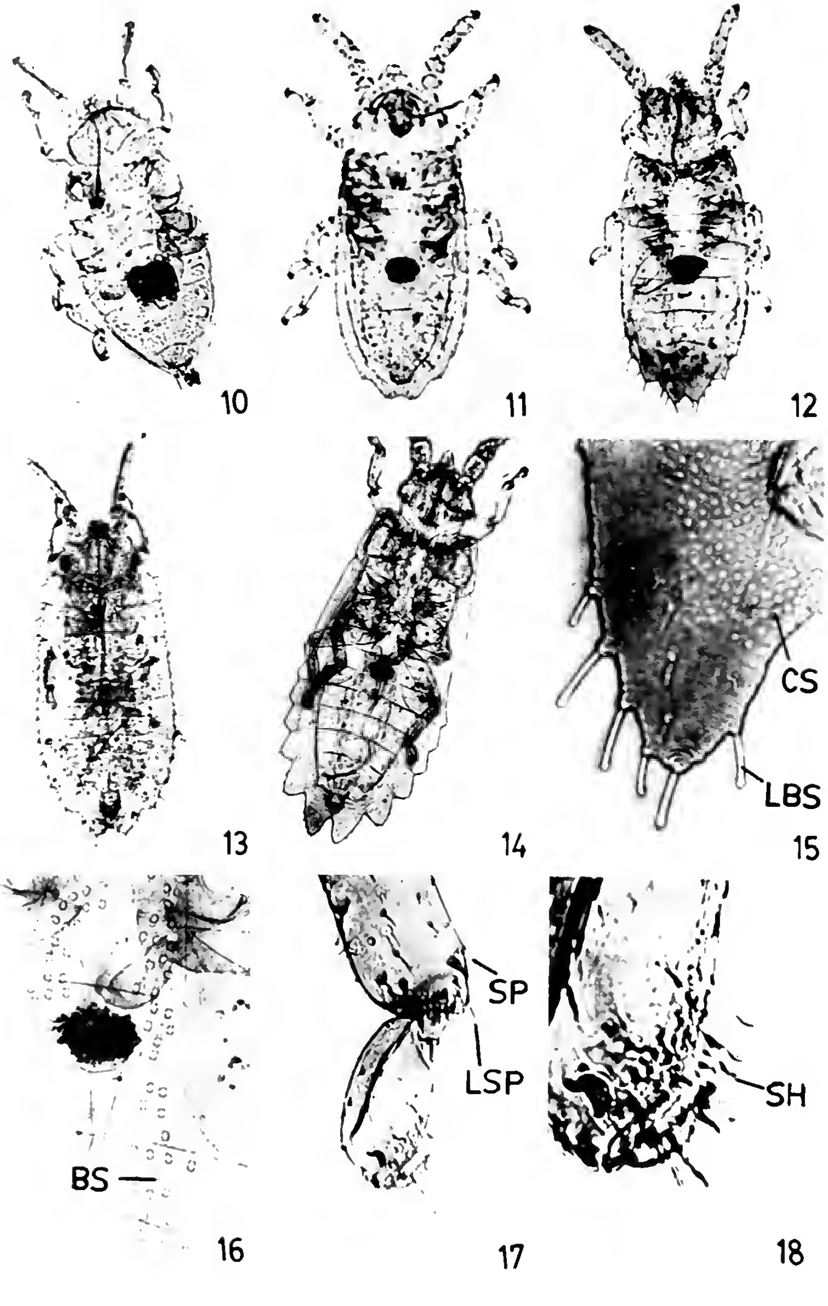
Nymphal morphology

A. hupehanum does not show any form of congregational behaviour, quite unlike several other species of foliage feeding species of tingidae. The cuticular and body outgrowths of the nymphal instars are classified according



Agramma hupehanum (Drake & Maa)

Fig. 1. Adult Male insect; Fig. 2. Forewing; Fig. 3. Entire egg; Fig. 4. Mouth of the egg (AP — Aeropyle, CHC — Chorionic collar, MT — Mouth of the egg); Fig. 5. Operculum (OPF — Posterior opercular flange. APF — Anterior flange, OPP — Opercular plate); Fig. 6. Parasitised egg (Notice the compound eyes and ocelli of the parasite); Fig. 7. Egg shell after parasite emergence; Fig. 8. Trichogrammatid egg parasite, *Lathromeromyia* sp.; Fig. 9. Mymarid egg parasite, *Parallelaptera* sp.



Agramma hupehanum (Drake & Maa)
Figs. 10-14. I-V nymphal instars; Fig. 15. Cuticular spherules (CS) & Long, blunt spines (LBS); Fig. 16. Biradiate Scoli (BS); Fig. 17. Short spine (SP) and long spines (LSP); Fig. 18. Spatulate hairs (SH).

TABLE 1

MORPHOMETRIC ANALYSIS OF THE NYMPHAL INSTARS OF *Agramma hupehanum* (IN MM.) N = 6

Stages	Entire		Head		Prothorax		Wing Pad		Antennae				
	Length	Width	Length	Width	Length	Width	Length	Width	I	II	III	IV	Total
I	0.675	0.252	0.182	0.189	0.07	0.252	–	–	0.028	0.028	0.049	0.84	0.196
II	1.04	0.364	0.266	0.28	0.126	0.364	–	–	0.056	0.056	0.084	0.091	0.28
III	1.064	0.385	0.268	0.28	0.154	0.385	Not discernible		0.056	0.056	0.091	0.091	0.329
IV*	1.008	0.378	0.21	0.238	0.126	0.378	"		0.07	0.056	0.12	0.098	0.356
V	1.68	0.525	0.328	0.343	0.351	0.525	0.49	0.276	0.094	0.070	0.189	0.151	0.518

* Only one specimen was available.

to Livingstone (1978). Morphometric analysis (Table 1) of the nymphal instars reveals that the length of the body, the antennae and the wing pads make significant growth in the fifth instar nymph.

The cuticular and body outgrowths are:

a. **Cuticular spherules** (Plate II, Fig. 15, CS). These are developments of epicuticle as minute spherical concretions (0.0034 mm diameter), corresponding to the "circle shaped structures" of Stusak (1968). In the first instar they are distributed on the middorsal line only. In the successive instars they are distributed laterally and intersegmentally, but never on the appendages.

b. **Biradiate scoli** (Plate II, Fig. 16, BS). These are developments of the entire cuticle (0.023 mm long) and they first make their appearance in the second instar as biradiate eruptions on the occiput, frons, clypeus and on the dorsomedian line of the thorax and abdomen. Their arrangement becomes erratic as their number keeps on increasing in the successive instars. Similar biradiate scoli have been reported by Rodrigues (1978) in the fifth instar nymph of *Agramma maynei* and they correspond to the "villi like tiny excrescences" of *Tingis stachydis*, as described by Stusak (1968).

c. **Spatulate hairs** (Plate II, Fig. 18 SH). These are spoon shaped hairs (0.02 mm long), having very restricted distribution on the ventral surface of the distitarsus. They can be readily distinguished from the globulated spines by their characteristic shape. Such hairs are not reported by earlier workers in Tingidae and they appear to be sensory, having some functional significance for this positively geotaxic species.

d. **Short, sharp spines** (Plate II, Fig. 17 SP) These are nonpedicellate short spines (0.017 mm long), found on the antennomeres and tarsomeres.

e. **Long, slender, sharp spines** (Plate II, Fig. 17 LSP) These are development of the entire cuticle, as pedicellate spines. They are distributed at the tip of the antennae, tibiae and tarsomeres. Their pedicel remain constant in length (0.0034 mm) but the length of spine increases steadily in the successive instars.

f. **Long, slender, blunt spines** (Plate II, Fig. 15, LBS). These are similar to the long slender sharp spines in their development and in having the pedicel length remaining constant in the successive instars. But they differ from the latter in being blunt apically and they are distributed on the head, lateral margins of the thorax and the dorsal and lateral margins of the abdomen. They make their appearance in the first instar, gradually increase in length in the successive instars and reach their maximum length (0.04 mm) in the 4th instar (Plate II, Fig. 13). In the 5th instar they are reduced to mere rudiments (Plate II, Fig. 14). They are not comparable to the globulated spines of other species of tingids and they do not exhibit the phenomenon of sweating, as commonly reported to be so on the globulated spines of other species of Tingidae. (Livingstone 1978 and Livingstone *et al.* 1981).

General remarks on the immature stages

Following their sequential order of development on the lateral margins of thorax and abdomen, the long blunt spines of the nymphal instars of *A. hupehanum* can be readily categorised as primaries, secondaries, tertiaries etc., as in the thoracic segments of *Dasytingis rudis* (Livingstone 1976) and *Pontanus puerilis* (Livingstone *et al.* 1981). Primaries always occupy the posterolateral position of each segment and the subsidiaries always develop anterior to them, except on the 9th segment of the 3rd (Plate II, Fig. 12) and 4th (Plate II, Fig. 13) instars. In all other species of Tingidae, whose nymphal morphology is known, the marginal tubercles of the abdomen while increasing in complexity in the successive instars, are seldom found to be added by subsidiaries in the successive instars, as observed in *A. hupehanum*.

The more significant morphological features

Table 2

Sequemental arrangement of the spines on the abdomen and thoracic segments of the nymphal instars

Segments	I Instar	II Instar	III Instar	IV Instar	V Instar
Prothorax	–	–	1	3, 1, 2, 3	Reduced in
Mesothorax	–	–	1	1, 3, 2, 3	to rudiments
Metathorax	–	–	–	1, 2	,,
II abd. segment	–	–	–	–	,,
III ,,	–	–	1	1, 2	,,
IV ,,	–	–	1, 2	1, 2	,,
V ,,	–	–	1, 2	1, 2	,,
VI ,,	–	1, 1	1, 2	1, 2	,,
VII ,,	–	1	1, 2	1, 2	,,
VIII ,,	1	1, 2	1, 2	1, 2	,,
IX ,,	1	1, 2, 3, 3	1, 2, 2, 3	3, 1, 2, 2, 3	,,

of the nymphal instars of *A. hupehanum*, not commonly reported earlier in the nymphal instars of other species of Tingidae are:

a) Only one pair of tubercles, that make its appearance only on the head (clypeal) in the first instar, continues to grow and persist in the adult. These two tubercles are bare, unlike those of other known species of Tingidae in which such tubercles are always reported to be of the compound type (Livingstone 1968).

b) Marginal spines of the thorax and abdomen first make their appearance on the 9th abdominal segment in the first instar and in the subsequent instars (Table 2) they progressively develop anteriorward and reach their maximum number and development in the 4th instar (Plate II, Fig. 13). In the final instar, they are reduced to mere rudiments (Plate II, Fig. 14), unlike those of other species of Tingidae whose nymphal morphology is known.

c) The cephalic spines that make their appearance in the 3rd instar, grow to the maximum number and size in the 4th instar : genal pairs 4; frontal pairs 4 and clypeal pairs 2. In the fifth instar they are either reduced to rudiments or lost.

(d) Total absence of globulated spines and their secretory globules which are commonly found in most other species of Tingidae.

(e) Presence of spatulate hairs on the under surface of the distitarsus.

Egg parasites

Tingid egg parasites have been reported earlier by Livingstone (1963 & 1976), May (1977) and Livingstone *et al.* (1981). In *A. hupehanum* the eggs are parasitized by *Lathromeromyia* sp. (Plate I, Fig. 8), a Trichogrammatid and by *Parallelaptera* sp. (Plate I, Fig. 9) a Mymarid. Both parasites occur simultaneously, parasitising the eggs of the same batch, deposited on the same leaf. All the parasitised eggs can be readily recognized by the accumulation of one or two patches of opaque material at the posterior end of the egg and in a more advanced stage of parasite development the two compound eyes and the three ocelli of the parasite appear conspicuously as reddish patches (Plate I, Fig. 6). Livingstone (1976) while reporting such a phenomenon, appeared to have mistaken the three ocelli of the parasite to be the five ommatidia of the host, thereby giving the interpretation that the parasite embryo develops at right angle to the host embryo.

While the nymphs from healthy eggs emerge through the mouth of the egg by lifting the operculum, the parasites from a parasitised egg emerge by making an exit opening on the chorion immediately behind the mouth of the egg, mostly on the convex surface (dorsal ?) of the egg (Plate I, Fig. 7). Emergence of the parasite through an aperture made at the posterior end of the egg is also not uncommon (Plate I, Fig. 9).

Acknowledgements

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OCCURRENCE OF CAJANINAE IN THE INDIAN SUBCONTINENT, BURMA AND THAILAND[1]

L.J.G. VAN DER MAESEN[2], P. REMANANDAN,
N. KAMESWARA RAO, AND R.P.S. PUNDIR[3]

(*With three plates and five maps*)

The ICRISAT Gene Bank houses the world's most exhaustive collection of pigeonpea, *Cajanus cajan*, and its close relatives, which are classified in the subtribe Cajaninae, tribe Phaseoleae, family Leguminosae. Wild relatives have a significant role in pigeonpea improvement at present and in the future. Many of them are under threat of extinction, and some may be already extinct. ICRISAT botanists have been collecting Cajaninae from their major areas of occurrence which include India, Nepal, Burma and Thailand from 1975 onwards. This paper highlights the manner and frequency of occurrence of the species of *Cajanus* (incl. *Atylosia*), *Rhynchosia, Dunbaria, Flemingia, Paracalyx,* and *Eriosema* as observed during recent collection trips compared with herbarium records. Evidently the habitats of several species have shrunk. Some species, such as *C. elongatus* and *C. villosus* from NE India and *C. grandiflorus* in N and NE India are so difficult to find that they may be close to extinction. These species need to be salvaged. Others may be extinct in some habitats, such as *C. sericeus* from the Eastern Ghats.

INTRODUCTION

Pigeonpea, arhar, tur, or red gram, *Cajanus cajan* (L.) Millsp., is an important food legume in India. In 1983 India grew 2 498 600 ha (Anon. 1983). The world area was 2 951 000 ha in 1980, and India produced 1 800 000 out of 2 017 000 tons (unpublished FAO data file). Outside India pigeonpea is one of the major pulse crops in Eastern Africa, particularly Kenya, Uganda, Malawi and Tanzania, and in the Caribbean region. It is grown to a smaller extent in many other tropical countries between 30 S and 25 N, often in mixtures or in subsistence-farming situations, and is therefore not properly accounted for in statistical reports. In those cases a survey on the basis of herbarium records can give better information about the distribution of pigeonpea (van der Maesen 1983), even when plant explorers often ignored cultivated plant species, and it does not specify the extent of cultivation.

For pigeonpea improvement a large germplasm collection is a prerequisite. The genetic resources of any crop include wild species, which have been exposed to severe selection pressures. Wild relatives of the pigeonpea have the potential to contribute desirable genes, and provide insight into the evolution and diversification of the crop. These species are often difficult to obtain, due to genetic erosion in impoverished or diminishing habitats, and local endemism. On the other hand, rare species may prove of more common occurrence than expected from the records, when intensively sought.

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In a taxonomical revision of *Cajanus* DC. (van de Maesen 1985) *Atylosia* has been declared congeneric with *Cajanus*, based on comparative morphology, cytology, chemical data and crossability. The earlier distinction between the genera was mainly based on the absence or presence of a seed strophiole. *Cajanus cajan* has a vestigial strophiole, conspicuous in the developing seeds, and in some cultivars this structure persists at maturity. Some pigeonpea seeds are indistinguishable from *Atylosia* seeds, all of which have a persistent strophiole. The enumeration lists all 17 species of *Cajanus* from the area under consideration, in total this genus now has 32 species. Maps 1 and 2 show the distribution of the species, based on herbarium study and explorations. We still have not yet collected four of these species from India and Burma.

Other wild genera related to pigeonpea, *Rhynchosia, Dunbaria, Flemingia, Paracalyx*, and *Eriosema*, are also classified in the subtribe Cajaninae of the tribe Phaseoleae. Other Cajaninae genera not mentioned here are small and mainly of African distribution (Lackey 1980). Both species described in the genus *Endomallus* are synonyms of *Cajanus goensis* Dalz. (van der Maesen 1985). Although less closely related, it would be useful to continue and complete collection of these genera for possible future utilization, and possibly to salvage them from extinction.

Occurrence of *Cajanus* spp. and other Cajaninae

Other than the basis of information gathered from herbaria and literature, several pointed collections were made between 1975 and 1983 to collect Cajaninae. In India generally two periods are suitable for collection of seeds of wild legumes : in October-November after the monsoons, and from February to April after the cool season, depending on area and species. After a wet monsoon the plants will flower longer, and produce seeds for a longer span of time. In some areas of South India, December and January are also suitable for collection.

Precise location data of the collected Cajaninae are listed in various Genetic Resources Unit Progress Reports (limited availability at ICRISAT), hence they are not repeated here. The locations of *Cajanus* spp. are also listed for the specimens examined in a monograph (van der Maesen 1985). This paper summarizes the recent findings in comparison with the old records, in an attempt to visualize the present distribution of *Cajanus* species on maps, and to point to possible extinction.

Wild species in pigeonpea improvement

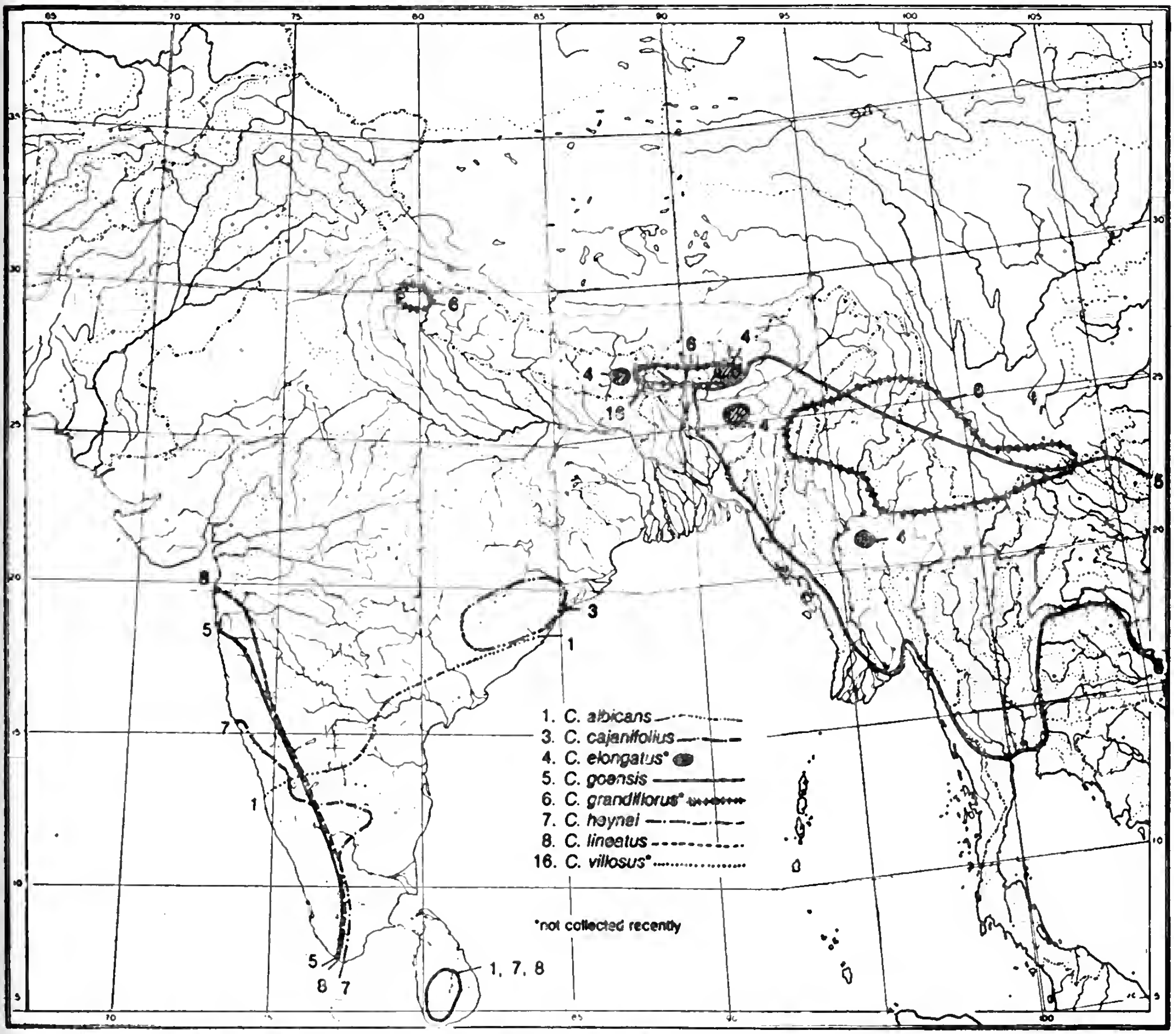
Several cross combinations of wild with cultivated *Cajanus* produce viable hybrids, which can be used as intermediaries to introduce genes from wild to cultivated genotypes. So far several Cajaninae have been screened and found to possess desirable traits. Remanandan (1981) summarized the utility of certain species. For instance, accession of *C. albicans, C. lineatus, C. sericeus* and *C. crassus* possess resistance to sterility mosaic, *C. scarabaeoides* has antibiosis to the pod borer, *Heliothis armigera*, and most species have high protein contents. Biochemically the relatives of pigeonpea are very interesting, for they have protease inhibitors that could provide selective resistance against certain insects, and are destroyed by cooking (Singh and Jambunathan 1981).

Many species are now on hand in the ICRISAT collection, but quite a few are rare and could not be found during our recent

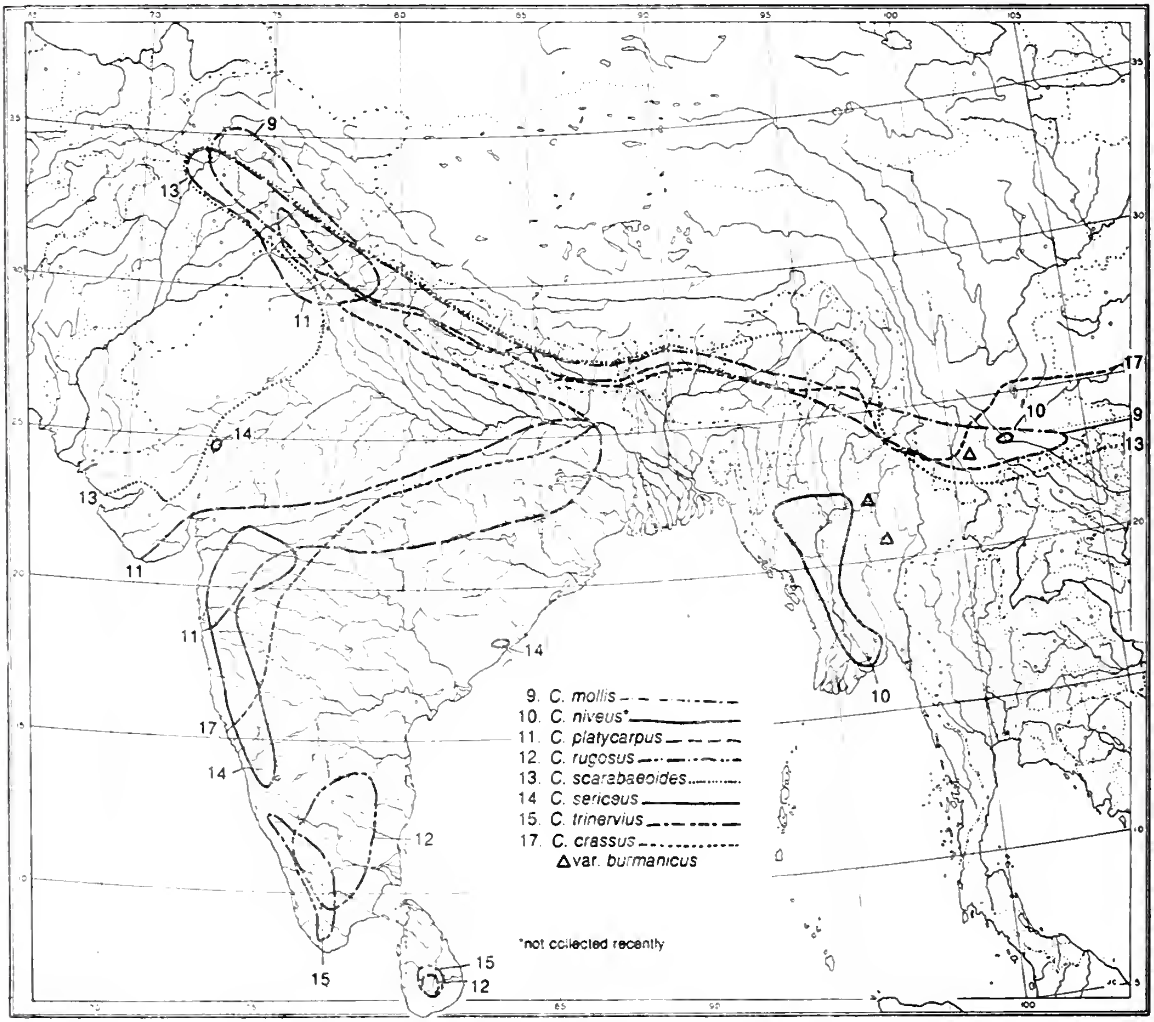
explorations. For introgression purposes viable seeds are required. We make an appeal to botanists to keep an eye on Cajaninae (and rare relatives of any crop species), and ICRISAT would be grateful to receive seed and herbarium samples of Cajaninae, in particular the species that have so far eluded collection. Detailed location data can be supplied upon request.

Maintenance of Cajaninae

Most Cajaninae have been grown successfully in ICRISAT's Botanic Garden. Those species native to India flower about the same time as in nature, except *Cajanus mollis* from the lower hills of the Himalayas, which flowers in early August at our Center instead of from mid-September onwards. *Cajanus trinervius*,



Map 1. Distribution of *Cajanus* spp. in South Asia.



Map 2. Distribution of *Cajanus* spp. in South Asia.

which is adapted to high altitudes, hardly survives at 600 m and does not flower. To execute interspecific hybridization, flower buds were collected in the Nilgiri hills and stored on ice in a thermos flask, and used for pollination *c.* 48 hours after collection. This technique was successful, and may be applicable to other species not adapted to the place of research.

At ICRISAT the species are not grown under shade, and apparently perennate not as well as in nature. On the other hand, growth tends to be luxurious, because competition is removed, and the plants are irrigated. Insect pests have to be controlled by spraying insecticides, for instance *C. albicans* tends to suffer from scale insects, especially in the second

year of growth. In nature pod borers and pod flies also attack *Cajanus,* but e.g. *C. scarabaeoides* possesses mechanical resistance and antibiosis aganist pod borers. Seeds shatter and have to be collected daily or biweekly. The foliage of most Cajaninae appears palatable to cattle, another factor limiting the survival of wild pigeonpeas.

Many seeds of Cajaninae have hard seedcoats, and tend to exhibit dormancy. As a routine, seeds are scarified before sowing by a sharp instrument. Seed dormancy can also be removed by sulphuric acid 98% treatment for 30 minutes (N. K. Rao *et al.*, n.d.)

At ICRISAT seeds are preserved at +4 C and 30% RH, to ensure longevity and viability.

Enumeration of Cajaninae

Cajanus (incl. *Atylosia*)

Cajanus albicans (Wt. & Arn.) vdMaesen

INDIA: Andhra Pradesh, Karnataka, Kerala, Tamil Nadu. SRI LANKA (500-1700 m). Quite common, recent finds many. Retreated to more or less undisturbed forests, near open spaces, climber in trees or shrubs. Fl. Oct.-Apr.

Cajanus cajan (L.) Millsp.

PANTROPICAL (0-2000 m). Widely cultivated in India, the pigeonpea, arhar, tur or red gram. Very rarely surviving as an escape, since grazing is severe outside protected areas. Fl. Sept.-April.

Cajanus cajanifolius (Haines) vdMaesen

INDIA: endemic of the E. Ghats of NE Andhra Pradesh, Puri and Koraput district of Orissa, and Bastar district of Madhya Pradesh (Bailadila) (500-1280 m). Very rare, found in more locations when searched for. So far known from less than twenty accessions. The closest relative of pigeonpea. Erect shrub in not too dense forests. Fl. Nov-Apr.

Cajanus crassus (Prain ex King) vdMaesen (= *C. volubilis* sensu Gamble)

BURMA, INDIA: quite widely distributed except Rajasthan, Kerala and Tamil Nadu, nowhere frequent. JAVA, NEPAL, MALAYA, PHILIPPINES, THAILAND, VIETNAM (0-800 m). Climber on trees or shrubs, sal, teak or pine forests, along streams and on dry soils. In Burma var. *burmanicus* pods have long semicaducous golden brown hairs, var. *crassus* has short puberulous pods. The only wild pigeonpea on the Andaman Islands. Fl. Jan.-March.

Cajanus elongatus (Benth.) vdMaesen

BHUTAN, BURMA, INDIA: Assam, Meghalaya: Khasi hills, Iseira river. Mairung, Sorjung, Mowphlang, Nongpoh, Nunkloes, Laitlyngkot, near Kynshi, Nilpara (up to 2000 m), last collected in India in November 1957, in West Bengal: Nilpara; NEPAL, last collected in 1967; VIETNAM. Very rare, not found recently despite thorough searches, may have faced extinction due to habitat destruction. Collection and preservation warranted. Twiner on grasses. Fl. July-Nov.

Cajanus goensis Dalz.

BANGLADESH, BURMA, CHINA: Yunnan; INDIA: Arunachal Pradesh, Assam, Karnataka, Kerala, Maharashtra, Meghalaya, Mizoram, Tamil Nadu, Tripura; INDONESIA, LAOS, MALAYSIA, THAILAND, VIETNAM (0-1500 m). A peculiar disjunct distribution. Climber in shrubs and trees, dry deciduous or moist forests, in shade or near open places. Fl. Aug.-March, mainly Jan.-Febr.

Cajanus grandiflorus (Benth. ex Baker) vdMaesen

BHUTAN, BURMA, CHINA: Yunnan; INDIA: NE Uttar Pradesh: Bagesar (Bageshwar), Kumaon; Upper Garhwal, Manipur: Huining, Naga Hills, Laimatak; Sikkim: Little Rangit river; lower hills. In India last found in Mani-

pur in 1948. Collection warranted. Fl. July-Nov.

Cajanus heynei (Wt. & Arn.) vdMaesen
(= *Dunbaria heynei* Wt. & Arn.)

INDIA: W. Ghats of Goa, Karnataka, Kerala, Maharashtra, Tamil Nadu, also rarely in the plains. Not uncommon, this species found a refuge over a large area in S. India, but frequence of occurrence is low. Climber on shrubs and trees. Fl. Dec.-March.

Cajanus lineatus (Wt. & Arn.) vdMaesen

INDIA: W. Ghats of Goa, Karnataka, Kerala, Maharashtra, Nilgiri hills of Tamil Nadu; SRI LANKA, found there only once and not traced recently (400-1660 m). The commonest of shrubby *Cajanus* spp., surviving on ungrazed ledges, hillsides of difficult approach or where grazing is limited, here and there in large populations. Fl. Oct.-Apr.

Cajanus mollis (Benth.) vdMaesen

BHUTAN, INDIA: Arunachal Pradesh, Himachal Pradesh, Meghalaya, Sikkim, Uttar Pradesh, Himalaya hills; NEPAL, PAKISTAN (700-2000 m). Not uncommon, always found in populations of a few or single plants. Climbing on shrubs, pine and broadleaf trees. Fl. Sept.-Nov.

Cajanus niveus (Benth.) vdMaesen

BURMA, CHINA: Yunnan (0-1350 m). Last found in 1950 between Mandalay and Maymyo, open jungle, hill sides of upper and lower Burma, may be found in NE India. Fl. Aug-Dec. Collection warranted.

Cajanus platycarpus (Benth.) vdMaesen

INDIA: Bihar, Delhi, Gujarat, Himachal Pradesh, Madhya Pradesh, Maharashtra, Orissa, Uttar Pradesh; INDONESIA, NEPAL, PAKISTAN (50-2600 m). Trailing in grasses, along roadsides, in pine forests, this species suffers from grazing and is far from common except when left alone. The earliest flowering species, tends to grow annual, perennates when conditions are favourable. Not always found where collected earlier. Fl. Aug.-Oct.

Cajanus rugosus (Wt. & Arn.) vdMaesen

INDIA: South peninsular hills; SRI LANKA (1300-2400 m). Recently only found in the Shevaroy hills and Sri Lanka. Tends to be confused with *Rhynchosia filipes*, which is common around Kodaikanal. Twining and creeping in forests, low shrubs and in open grassy downs. Fl. June-July, Sept.-April, mainly Dec.-Jan. Appears to be on the verge of extinction.

Cajanus scarabaeoides (L.) du Petit-Thouars

S and SE ASIA, parts of OCEANIA, coastal AFRICA, MADAGASCAR, JAMAICA (0-1000 m). The commonest wild species, creeping/climbing in open grass lands, dry scrub or (semi) deciduous forests such as sal and teak. The only species which is of frequent occurrence almost all over India. Fl. Sept.-April.

Cajanus sericeus (Benth. ex Baker) vdMaesen

Endemic of INDIA: Western and Eastern Ghats, Mt Abu, Satpura Mts. (500-1300 m). Recently only found in the Western Ghats near Pune, not found on Mt Abu, Endrika Hill of Visakhapatnam Hills. Undershrub in dry deciduous forests, grassy lands and hill slopes. Fl. Sept.-Febr.

Cajanus trinervius (DC.) vdMaesen

Hills and hill tops of S INDIA and SRI LANKA (850-2650 m). In shrub vegetation, semi-open evergreen forest, grasslands, between boulders. Quite localised, this shrub forms populations of a few dozen plants where left undisturbed. Flowers throughout the year, except July, seeds most likely to be present Jan.-March.

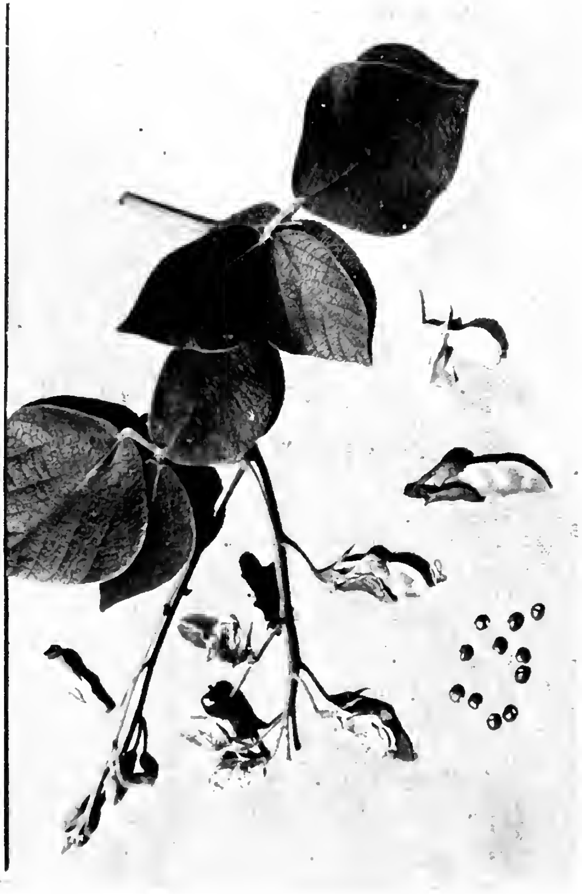
Cajanus villosus (Benth. ex Baker) vdMaesen

INDIA: endemic of Sikkim and NW Bengal, Terai plains, and foothills (150-1300 m). Creeper in grasses and low shrubs, very rare, last collected in 1895 in the Eastern Duars. Possibly extinct. Fl. Sept.-Oct.

Cajanus cajanifolius (JM 2739)

Cajanus lineatus (W. Ghats)

PLATE II



Dunbaria ferruginea (JM 3509)

Rhyncosia rothii (JM 2296)

Dunbaria

Dunbaria circinalis Baker

BURMA, INDIA: Assam, Sikkim. A slender climber.

Dunbaria debilis Baker

INDIA: Meghalaya, Nurting or Nurtiung (1300 m). Only known from a few old specimens.

Dunbaria ferruginea Wt. & Arn.

Hills of S INDIA, SRI LANKA. More common and vigorous than most large *Cajanus* climbers, this species is commonly found in populations of a few large specimens covering shrubs or entire trees. Fl. (Sept.-) Dec.-Febr.

Dunbaria fusca (Wall.) Kurz

BURMA, INDIA, LAOS, THAILAND, VIETNAM (0-1500 m). A rather little-known species.

Dunbaria glandulosa (Dalz.) Prain

INDIA: Assam, Maharashtra. Fl.: Aug.-Sept. Rare, localised.

Dunbaria podocarpa Kurz

BURMA, CHINA, CAMBODIA, INDIA: Assam: Lushai hills, Mizoram: Aizal; LAOS, VIETNAM (1000-1500 m). A climber. Fl. Nov.-April.

Dunbaria rotundifolia (Lour.) Merr.

(= *D. conspersa* Benth.)

AUSTRALIA, BANGLADESH, BURMA, CHINA, INDIA: Assam, West Bengal, Peninsula; MALAY PENINSULA, PHILIPPINES. Found once recently, near Jalpaiguri. Climber on grasses. Fl. Nov.

Eriosema

Eriosema chinense Vogel

AUSTRALIA, BURMA, INDIA: Himalaya foothills; MALAYSIA, PHILIPPINES, SRI LANKA. The only species in India, in Africa this genus counts many species. Not found by ICRISAT collectors. Tubers edible (Singh & Arora 1978).

Flemingia (= *Moghania*)

We follow the treatment of Nguyen Van Thuan (1979), which does not conform with those in Prain (1903), Gamble (1918) or Ali (1977). Ali recognizes the Baker (1876) varieties as species. Thuan does not distinguish them for the flora of Vietnam, but some are distinct enough. Nair (1977) uses the split species, under *Moghania*. The genus is presently receiving attention for the Flora of India (Thothathri, pers. commun.). The species and the recent finds are reflected in Map 3.

Flemingia chappar Ham. ex Benth.

BURMA, CAMBODIA, INDIA: Bihar, E Himalayas, Orissa, S. India, THAILAND, LAOS (0-1000 m). In dry, open forests, on poor soils, common in eastern part of area. Erect shrub. Fl. Dec.-Jan.

Flemingia ferruginea Grah. ex Benth.

BHUTAN, BURMA, INDIA: Nilgiris; LAOS, PHILIPPINES, THAILAND. On the plains, along streams, and in wet inundated forests. Erect shrub.

var. **fluminalis** (C. B. Clarke ex Prain) Nguyen Van Thuan.

BURMA, CHINA, INDIA, LAOS, VIETNAM (0-500 m). Along rivers, on sandy and clay loam soils.

var. **glutinosa** Prain

BURMA, LAOS, THAILAND, VIETNAM. Open forests, uncultivated areas. Erect shrub with long glandular hairs.

Flemingia grahamiana Wt. & Arn.

AFRICA, BURMA, CHINA, INDIA: Nilgiri and Palni Hills, W Karnataka; LAOS, VIETNAM (0-1500 m). Of very localised occurrence, not rare. FL. Oct.-Febr.

Flemingia involucrata Benth.

S & SE ASIA, INDIA: E Himalaya, Assam, Sikkim, Konkan (0-1100 m). In open forests, along coast, hillsides. Erect shrub.

Flemingia lineata (L.) Roxb. ex Ait. f.

var **lineata.**

CAMBODIA, INDIA: widely distributed; LAOS, SRI LANKA, VIETNAM (0-600 m). Erect shrub

in plains, open forests, along rivers. Fl. Febr.-March.

Flemingia macrophylla (Willd.) Prain

BURMA, CAMBODIA, CHINA, INDIA: from the Himalayas to South Peninsula. LAOS, PAKISTAN, SRI LANKA, THAILAND (0-2000 m). In dense and open forest, hedges, on hills, along rivers, on red and clay soils. Quite common, often collected, also recently. Fl. Oct.-March.

var. **nana** (*F. nana* Roxb.)

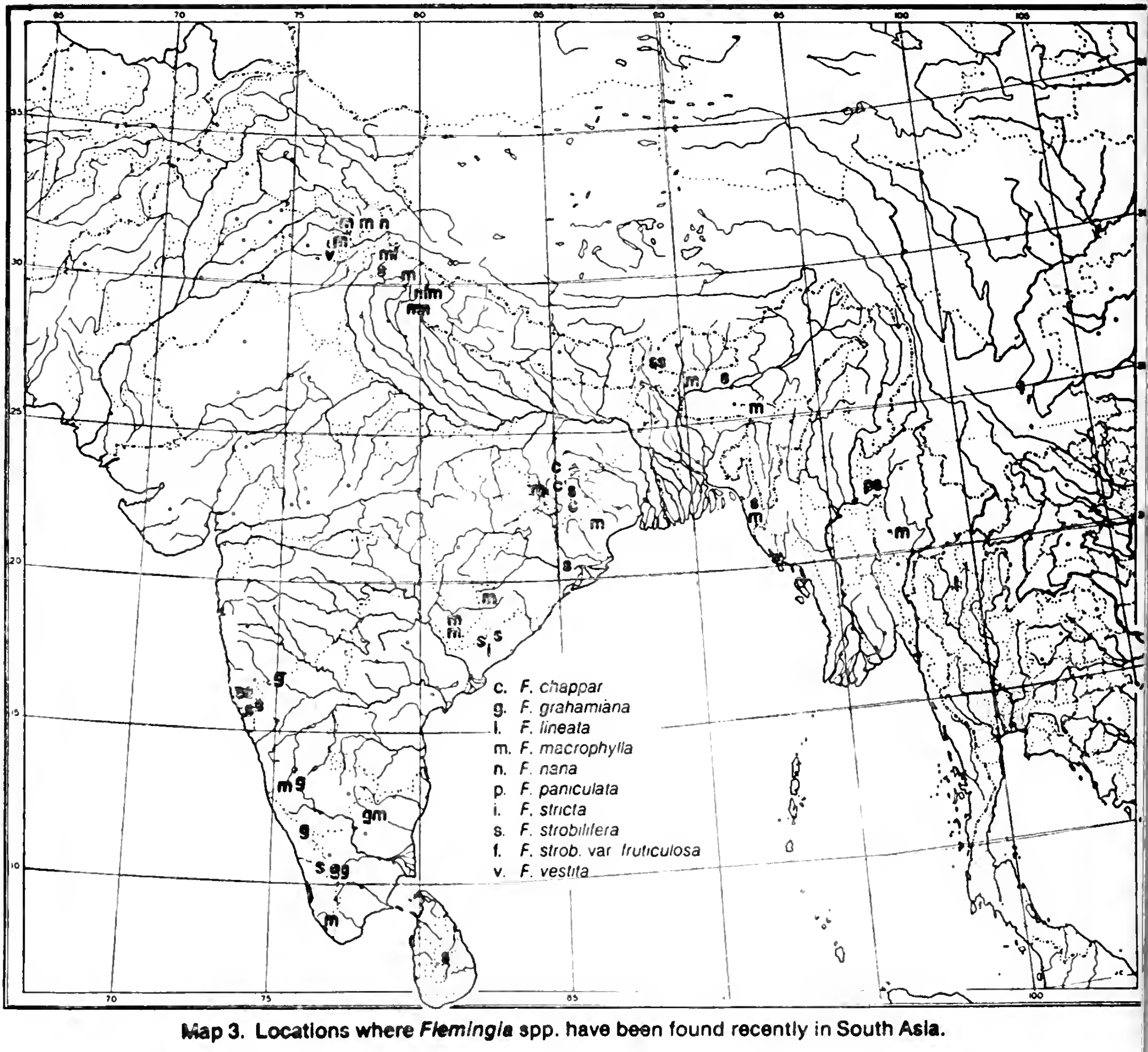
INDIA: C & E Himalayas, Konkan (800-1600 m). Found twice recently, possibly not very rare.

Flemingia paniculata Wall. ex Benth.

forests. Erect shrub. Fl. March.

THAILAND (0-1100 m). Localised in bamboo

BURMA, INDIA: C & E HIMALAYA; LAOS,

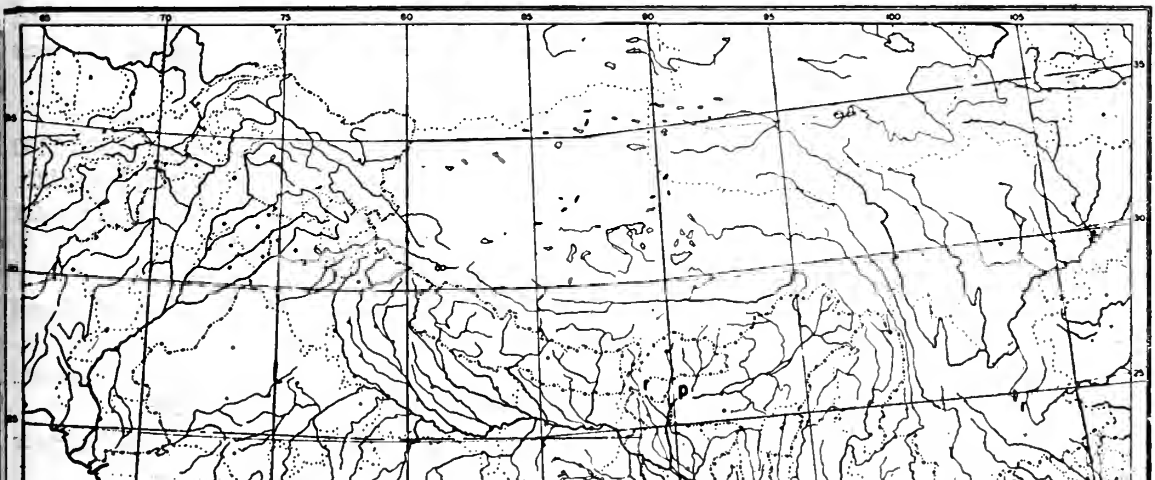


Map 3. Locations where *Flemingia* spp. have been found recently in South Asia.

Flemingia procumbens Roxb.
(= *F. vestita* Benth. ex Baker ?)
S & SE ASIA, INDIA (0-1700 m): Himalayas. *F. vestita* is wild, and also cultivated for its edible tuber (Singh & Arora 1974). Fl Oct.-Nov. Synonymy by Thuan questionable.

Flemingia stricta Roxb. ex Ait. f.
S & SE ASIA, INDIA: Assam, W. Peninsula (0-1200 m). In dense or open forests, along streams, near rice fields and on rocky soil. Robust shrub. Fl. Oct.-March.

Flemingia strobilifera (L.) Ait. f.
var. **strobilifera.**
S & SE ASIA, INDIA, PAKISTAN (0-1500 m). Open forests and grasslands, reasonably common, tall erect shrub. Fl. Oct.-March.



Map 4. Locations where *Dunbaria* and *Paracalyx* spp have been found recently in South Asia.

var. **fruticulosa** Baker.

INDIA, NEPAL, PAKISTAN (up to 1600 m). Forests, a prostrate form. Fl. Oct.-March.

Flemingia tuberosa Dalz.

INDIA: Maharashtra, W Ghats along the coast. Trailing herb. The tuberous roots are eaten (Singh & Arora 1978). Fl. Sept.-Oct.

Paracalyx

Paracalyx scariosa (Roxb.) Ali

BURMA, INDIA: forest edges and roadsides of Goa, Karnataka, Maharashtra, and Orissa; THAILAND (0-1300 m). Conspicuous with its white papery extended calyx. Of occasional occurrence. Fl. Nov.-Febr.

Rhynchosia

Rhynchosia acutissima Thwaites

INDIA: Kerala, Meghalaya, Sikkim; SRI LANKA. Rare, specific status under review. Fl. Dec. (Kerala).

Rhynchosia avensis Benth. ex Bak.

BURMA: endemic (800-1200 m). Rare, specific status under review. Fl. Nov.-May.

Rhynchosia aurea DC.

INDIA, SRI LANKA (0-800 m). Creeper on grasses, widespread and quite frequent, harvested along with grasses for hay and grazed extensively. Not unequivocally distinguishable from *R. nummularia* DC. and *R. capitata* (Roth) DC. Ali (1977) retained *R. capitata*, and did not discuss *R. aurea*. Fl. Sept.-Jan.

Rhynchosia bracteata Benth. ex Bak.

BURMA, INDIA: Upper Gangetic Plain, S Andhra Pradesh, LAOS, THAILAND (0-1000 m). Found by ICRISAT collectors in a large population E of Mandalay, along roadside near forest, and in few specimens near the Mahanandi Temple (A.P.), and in NW Thailand. Very vigorous, so despite its scattered occurrence not likely to become extinct. Fl. Dec.-March.

Rhynchosia cana DC.

INDIA, Peninsula; SRI LANKA (200-1400 m). A small erect shrub, not common and infrequent. Fl. Sept.-Febr.

Rhynchosia densiflora DC.

INDIA: Peninsula; E. AFRICA (200-1600 m). Slender twiner in grasses or shrubs. Not common. Fl. Nov.-Jan.

Rhynchosia falconeri Baker

INDIA: Garhwal, Shahli. Trailing herb, rare, not found recently, as also stated by Nair (1977).

Rhynchosia filipes Benth.

INDIA: Nilgiri and Palni Hills (1400-2300 m). A creeper on grasses, or hanging from cliffs. Endemic to small area, relatively frequent there. Fl. (Oct.-) Dec.-Febr.

Rhynchosia heynei Wt. & Arn.

INDIA: Andhra Pradesh, Karnataka, Tamil Nadu (*c.* 1000 m). An erect low shrub, collected twice in recent times from the Tirumalai hills, not common. Fl. Febr.-March.

Grows with difficulty at ICRISAT Center near Hyderabad (600 m).

Rhynchosia himalensis Benth. ex Baker.

BURMA, INDIA: Himachal Pradesh, N Punjab, Kumaon, Garhwal; PAKISTAN (1400-1700 m). Climber or trailing shrub, quite rare, collected once recently. Fl. Aug.-Oct.

Rhynchosia hirta (Andrews) Meikle & Verdcourt [= *R. cyanosperma* Benth., *R. albiflora* (Sims) Alston]

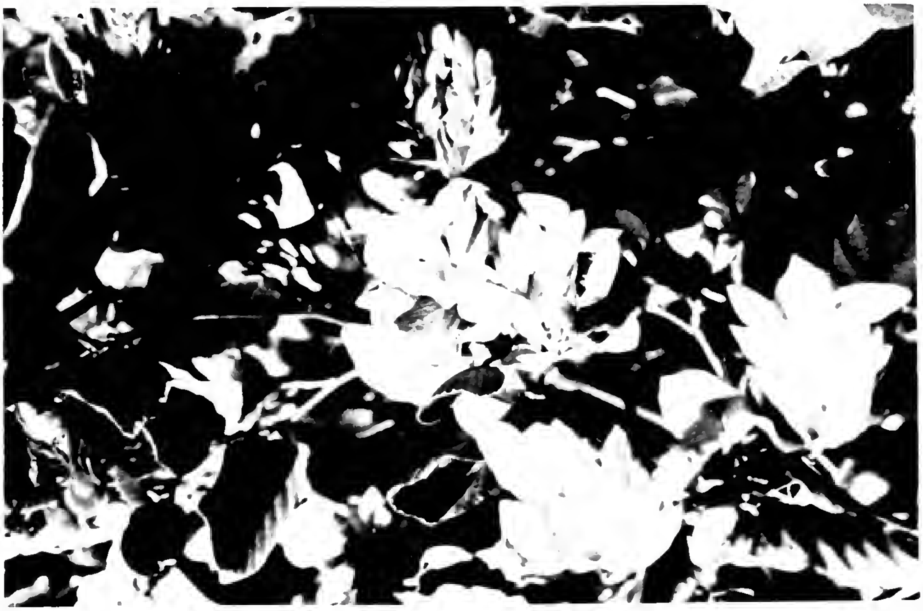
INDIA, SRI LANKA, E. AFRICA (600-1200 m). A robust woody climber in forests with peculiar blue seeds. Occasional. Fl. Dec.-March, mainly Jan.-Febr.

Rhynchosia memnonia DC.

ARABIA, PAKISTAN, TROPICAL AFRICA. Hardly more than a variety of *R. minima*, status under review.

Rhynchosia minima DC.

INDIA, everywhere in the plains and up to



Above: *Flemingia strobilifera* (PR 4664).
Below: *Cajanus lineatus* on hillslope near Devala, Wynad, Kerala.

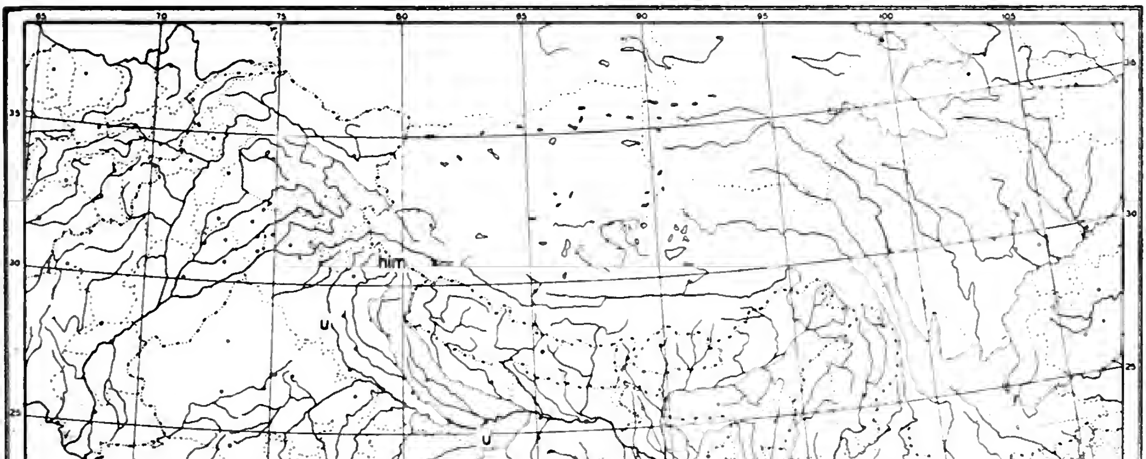
c. 1200 m in the Himalayas, COSMOPOLITAN. A slender creeping annual, very common in grasses and scrub vegetation. A useful pasture legume. Var. *laxiflora* (Camb.) Baker is, it seems, found more often as a climber. Fl. July-March.

Rhynchosia pilosa Wall. nom. nud.

BURMA, Segaen along the Irrawaddy. Rare, status under review.

Rhynchosia pseudo-cajan Camb.

INDIA: W. Himalayas; PAKISTAN (800-3000 m). An erect shrub, poorly represented in the herbarium and apparently rare. Not found when searched for. Last specimens are 1953 finds in RAW from Poonch, and in DD from Jakhri and Neerath in Himachal Pradesh. Fl. May-Oct.



Map 5. Locations where *Rhynchosia* spp. have been found recently in South Asia.

Rhynchosia pulverulenta Stocks

AFRICA, ARABIA, INDIA: Rajasthan, PAKISTAN: Karachi (0-200 m?). Found also recently. Fl. Jan.-July.

Rhynchosia rothii Benth. et Aitchis.

(= *R. sericea* Span.)

INDIA, from the Himalayas to the S Peninsula; PAKISTAN, MALAYAN PENINSULA (200-1300 m). Quite common in Southern India, climber perennating from woody roots, with purple and cream flowers. Fl. Sept.-Febr.

Rhynchosia rufescens (Willd.) DC.

BANGLADESH, INDIA: South Peninsula, SRI LANKA, JAVA (0-1800 m). A suberect low shrub with trailing branches, not rare in S. India, found recently at many occasions in forests and along roadsides. Fl. Oct.-April.

Rhynchosia schimperi Hochst. ex Boiss.

ARABIA, EGYPT, INDIA: Rajasthan; PAKISTAN: Thar desert. Quite rare. Altitude not reported. Fl. Sept.-March.

Rhynchosia suaveolens DC.

INDIA: South Peninsula, SRI LANKA (200-1000 m). Another low shrub with trailing branches, not rare in forests. Fl. Nov.

Rhynchosia velutina Wt. & Arn.

INDIA: Henry & Swaminathan (1979) rediscovered the species in South Indai: Vivekanandapuram near Cape Comorin.

Rhynchosia viscosa DC.

AFRICA, INDIA: widespread; MALAYA, MADAGASCAR, MAURITIUS, SRI LANKA (0-1000 m). Flowers yellow, not easy to distinguish from *R. rothii* if flower colour is unknown. Fl. Febr.

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THE BIRDS OF DURGAPUR AND THE DAMODAR VALLEY[1]

F. M. Gauntlett[2]

(With a map)

A systematic list is given of birds recorded by the author during a 3 year stay in Durgapur, West Bengal. The diversity of species was found to be comparable with other areas of lowland India. The seasonal occurrence of species is examined and compared with information for the Delhi area. Migrant species were much more numerous in spring than autumn.

Introduction

Ornithological observations were made for three years between January 1968 and March 1971 while I was residing in Durgapur, West Bengal and this paper summarises the results which it is hoped will fill a gap in the published literature. E. H. N. Lowther worked in the Dhanbad area to the west in the 1930's (Lowther 1949) and various observations have been made in the Calcutta area to the east but the intervening area appears to have been ignored by ornithologists except for the author's earlier paper relating to Durgapur Barrage (Gauntlett 1972). Some details of that paper are included, extended and amended where necessary with the third year of observations.

The literature available to assist the amateur field ornithologist and relevant to the area was sparse to start with, compared with other areas such as Europe, but has improved considerably since, particularly with the completion of the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Ali & Ripley 1968-1974), "The handbook" henceforth and King *et al.* (1975). The standards of field identification of certain difficult species and groups, particularly birds of prey, have also been greatly assisted by new information which has appeared in more recent years. Some of my records have been reassessed in the light of this new information.

Methods

All observations were made as a part time hobby, but were almost daily in and around my bungalow and garden and twice daily trip to and from my office approx. 1.3 km away. On Saturday afternoons and Sundays excursions were made locally or further afield as opportunity and inclination arose. See appendix 1 for frequency of visits to main locations.

A certain amount of travelling was necessary in the course of my work and these journeys were also used for casual observations. These trips were to Calcutta, usually by train, occasionally by car, when a track-side transect of birds was carried out to while away the time. Road journeys were made by car to Santaldih or Jamshedpur, the route being across the R. Damodar at the barrage then via Maliara, Kusthalia, Saltora, Ragunathpur, then either continuing westward to Dudra

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and Santaldih, or turning souwards to Purulia, Balarampur, Chandil and Jamshedpur. Purulia was taken as the arbitrary limit for ornithological records. Trips were also made by car north-west up the GT road to Topchanchi, turning south through Gomoh to Chandrapura. A driver was usually provided for these journeys.

When the possibilities of making an ornithological contribution were realised, a regular diary was kept from March 1968 onwards. Notes during the first two months acclimatisation and familiarisation period were rather more haphazard and dates quoted are best estimates. Inevitable absences occurred from time to time due to local or home leave and periods of a week or more are listed in appendix 2. The poor coverage for October will be noted.

The study area

Durgapur is a heavy industrial development begun in the early 1960's located at 23° 30′ North, 87° 15′ East on the north bank of the Damodar river 185 km NW of Calcutta about half way between Burdwan and Asansol in the Burdwan district of West Bengal. The industrial area was about 20 km long by 6-7 km wide on a low laterite ridge which was once dense sal jungle. At the stage of development reached during the author's stay it was a patchwork of factory compounds, housing colonies, villages, bustees, patches of sal jungle and scrub, a few tanks and jeels and bare eroded scrubby wasteland. The highest point of the area is the triangulation point at 371′ (113 m) above what was to become the town centre. The river level at the barrage is 219′ (67 m). The axis of the area is governed by the river and runs from WNW to SSE and is followed by the Grand Trunk Road and the main line of the Eastern Railway.

From NW through E to SE a level plain stretches away to the R. Ganges, R. Hoogly and Calcutta with a dense rural population devoted to rice cultivation. The Ajoy (or Ajay) river some 20 to 30 km to the north follows a similar directional trend.

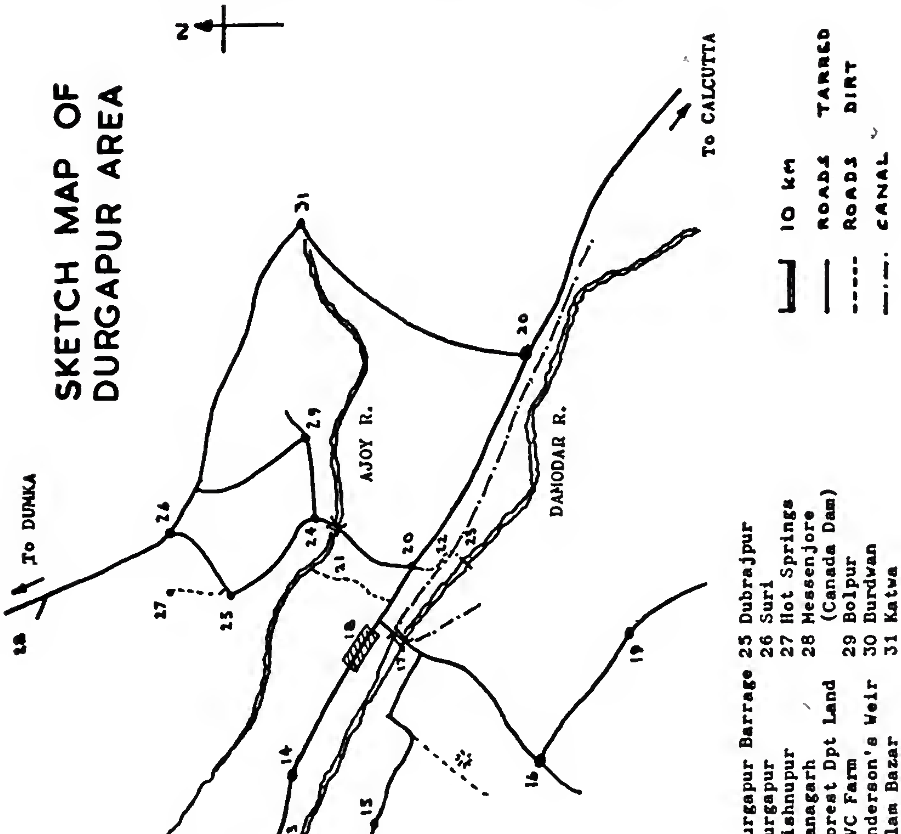
To the westward is the Jahria coalfield and the industrial towns of Asansol, Kulti, Burn, pur, Dishergarh and the country is more undulating with isolated volcanic outcrops culminating in Panchet Hill 2110′ (643 m) and the low hills around Maithon dam on the Barakar river which forms the border with Bihar. South of the Damodar river is Bankura district which is less fertile and more undulating, these trends being more pronounced in Purulia district which geographically resembles Bihar more than West Bengal.

Climate

The climate of Durgapur is tropical monsoon in character with most (+90%) of the annual rainfall (*c.* 1400 mm) falling in heavy thunderstorms from the end of May to early September during the SW monsoon (which actually comes in from the SE). The rainy season can sometimes be extended into October or November when fringes of cyclones in the head of the Bay of Bengal cover the area as was the case in 1970.

The monsoon is followed by a cool (relatively) dry winter from October to February although a little rain can occur in early January (known locally as Christmas rains). Day temperatures rise to around 18° to 24°C. Frost is unknown, the minimum temperature during my stay according to press weather report was 8.3°C.

From early March the temperature begins to rise and mid-day shade temperatures by mid April can be expected to reach 43°C and with 49°C not unknown in May. During the hot weather brief showers can be brought by


SKETCH MAP OF
DURGAPUR AREA
N
To CALCUTTA
To DUMKA
To JAMSHEDPUR
AJOY R.
DAMODAR R.
BARAKAR R.
G.T. ROAD
10 KM
ROADS TARRED
ROADS DIRT
CANAL
1 Parasnath Hill
2 Topchanchi
3 Gomoh
4 Chandrapura
5 Purulia
6 Dhanbad
7 Santaldih
8 Dubra
9 Ragunathpur
10 Panchet Dam
11 Panchet Hill
12 Maithon Dam
13 Dishergarh
14 Asansol
15 Saltora
16 Bankura
17 Durgapur Barrage
18 Durgapur
19 Bishnupur
20 Panagarh
21 Forest Dpt Land
22 DVC Farm
23 Anderson's Weir
24 Ilam Bazar
25 Dubrajpur
26 Suri
27 Hot Springs
28 Messenjore (Canada Dam)
29 Bolpur
30 Burdwan
31 Katwa

short lived localised squalls called Nor'westers. This was particularly so in 1969 which also had cyclonic rain in April.

Monsoon rainfall is notoriously fickle but was generous in all three years of my stay. A press report stated the 1968 monsoon was the wettest in West Bengal for 50 years. There was a particularly heavy spell of rain in September 1970 when *c* 400 mm fell in two weeks. Rainfall was particularly scant in the early months of 1968 following a poor monsoon in 1967 and marginal areas looked noticeably arid.

During the monsoon the flat countryside with all its paddy fields becomes a shallow swamp.

Flora

The flora of the region is tropical moist deciduous monsoon sal type, the Sal tree *Shorea robusta* forming a high proportion (+80% to my unbotanical eye) of the jungle community. Although sal trees lose their leaves during February and March, the individual trees are asynchronous and many trees can be found with old leaves, new leaves and flowers at the same time so that the canopy is never completely bare. The small proportion of truly deciduous trees which are bare at this time are insufficient to make much difference

The original forest cover has long since disappeared from the level fertile areas which have been turned into paddy fields and only pockets of overgrazed, overcut and eroded scrubby areas persist in less fertile areas. However I was fortunate that the last remnant of reasonably natural forest in the area about 400 m × 400 m began about 100 m from my bungalow. Here the trees produced a closed canopy about 9 to 11 m high but undergrowth and regeneration was suppressed by annual burning of the leaf litter in February. This jungle was visited about 2 to 3 times a week and unless otherwise stated references to sal jungle in the systematic list refer to this area. (I have heard that this was cut down some time after my departure). This block gradually deteriorated into a larger area of scrub about 1 km × 2.5 km, which itself was being whittled away by new roads and housing. A flush of ephemereal ground cover appeared in the sal jungle during the monsoon.

Somewhat similar but thinner areas of sal forest with trees 8 to 11 m tall had been retained in blocks and belts in unused parts of my housing colony as a deliberate policy.

A fairly extensive area of sal jungle under the control of the State Forest Dept some km north of Durgapur towards the Ajoy river was being developed into commercial plantations.

In the open countryside trees were generally confined to belts along roads and small clumps particularly around villages. A variety of trees are found as isolated specimens, such as silk cotton *Salmalia malabarica*, Peepul *Ficus religiosa*, Banyan *F. bengalensis*, Palmyra palm *Borassus flabellifer* and Date palm *Phoenix sylvestris* and these in conjunction with Mango *Mangifera indica* and Bamboo form much of clumps around the villages.

An area to the north of the GT road below and around the triangulation point which was to become the town centre had a very thin soil cover with underlying rocks breaking through supported a thin thorny scrub jungle.

Localities

Bungalow, garden and housing colony.

My bungalow and garden were situated in a housing colony near the crest of the ridge north of the GT road in sal jungle, of which as much as possible had been retained. My garden, and others like it, was about 0.27 ha

(2/3 acre) of lawn, flowerbeds and vegetable garden dotted with sal and other jungle trees. Flowering exotics included Gul Mohr *Delonix regia,* Frangipani *Plumeria rubra,* Hibiscus, Poinsettia *Euphorbia pulcherrima,* Oleander *Nerium odorum* and Malayan cherry *Muntingia calabura.* Bananas *Musa sapientum* and Papayas *Carica papaya* were grown for fruit. The bungalow and trees were draped with flowering climbers such as bougainvillea, bignonia, quisqualis, alamanda etc. It was screened from its neighbours and adjacent roads by hedges of sal trees with a thick undergrowth of hibiscus, lantana and other shrubs, again well covered with flowering climbers such as ipomoea, ixora, etc.

The verges of the colony roads were lined with trees such as Mango, Tulip tree *Spathodea campanulata,* Indian lilac *Lagerstroemia indica* and others. As stated above blocks of sal had been retained within the colony and were interspersed amongst the houses and gardens. The 400 m × 400 m block mentioned under "Flora" formed the boundary of the housing colony on one side. About half the distance of my daily trip to the office had sal jungle on both sides of the road and half past an area of waste ground with short grass dotted with dense clumps of bushes and a few palms with several hectares of paddy field beyond.

Durgapur Barrage.

This area was described in detail in my previous paper (Gauntlett 1972) and will not be repeated here. The heavy rain which fell in September 1970 occurred after that was written and the high river flows which resulted scoured out a lot of the incipient sand banks and water hyacinth *Eichhornia crassipes* islands. It will be referred to as DB in the systematic list.

Anderson's Weir.

This was a river control work built in the 1930's about 19 km downstream of Durgapur at Rondhia and its sluice fed a north bank canal but it has been rendered largely redundant by DB. The area around the inspection bungalow and head works had been landscaped and an avenue of large spreading trees of the Holm Oak type (*Quercus* sp. ?) planted along the approach road. Some acacias had also been planted on the sandy river terrace. Upstream of the weir siltation had produced large flat areas of wet sand and mud. Downstream were large stabilised sandbanks with a sparse growth of course grasses. This gave a rather desert like aspect to the area.

The north bank canal had been cut through a low ridge so that the banks were quite high, about 10-12 m and the inner slopes carried a dense growth of low thorny shrubs.

The area is referred to as AW henceforth.

DVC Experimental farm.

This was located between Panagarh (13 km ESE) and Rondhia alongside the Damodar canal on the way to AW. Parts of it were sometimes irrigated from the adjacent canal in winter providing a local wet environment in an otherwise dry landscape. The kutcha road ran along the top of the canal bank giving a wide view over the flat countryside.

Maithon Dam.

The Barakar river has been dammed at Maithon (53 km WNW) where it flows through an area of low rocky hills before joining the Damodar. Visits here were social functions at the invitation of the yacht club and bird watching was rather circumscribed. However the lake was very turbid and did not appear to support much bird life. Brief aquaintance of the thick scrub clothing the low hills showed

it to be a difficult and unpleasant habitat to work, undergrowth being mostly thorny stinging creepers and shrubs. Sal was still the predominate tree.

Messenjore Dam.

A single visit was made to this locality, also known as Canada Dam, the setting being rather similar to Maithon but the tree cover is more deciduous. It is about 70 km N of Durgapur.

Panchet Dam.

On the Damodar close to Maithon and very similar but with more barren surroundings except for the wooded mass of Panchet hill overlooking it.

Topchanchi.

The Jahria Water Board reservoir at Topchanchi is at the eastern foot of Parasnath hill 4481′ (1366 m) about 130 km WNW of Durgapur. The lower slopes of Parasnath and adjacent hills are well forested with much greater botanical variety than the sal jungle around Durgapur. Bamboo was much in evidence. Zoologically it is probably more akin to the Chotanagpur plateau than the Damodar valley.

Systematic List

The sequence and nomenclature follows the HANDBOOK, Ali and Ripley 1968-74 with English names for species according to the SYNOPSIS, Ripley 1982.

Podiceps cristatus (Linnaeus),
GREAT CRESTED GREBE

2 birds at DB on 8.ii.69 are the only record.

Podiceps ruficollis (Pallas),
LITTLE GREBE

A small resident population at DB with numbers buliding up to about 100 at the end of the hot weather in May when display and trilling recorded. Although none have been positively recorded elsewhere the marked drop in numbers at the start of the monsoon could indicate a dispersal to flooded jheels.

Phalacrocorax carbo (Linnaeus),
LARGE CORMORANT

Only three records, all at DB: In Feb. 1968, date uncertain, 3 on 20.xii.70 and 2 on 27.xii.70.

Phalacrocorax fuscicollis Stephens,
INDIAN SHAG

One at DB on 18.v.68 and a possible at AW on 20.i.68. A bird over my bungalow on 18.vi.68 which appeared bulkier than a Little Cormorant may also have been this species. Not easy to identify and may be more frequent than the records suggest.

Phalacrocorax niger (Vieillot),
LITTLE CORMORANT

A common and widespread resident on rivers, lakes, tanks, jheels, concentrating on the larger areas of permanent water in the dry season and spreading out widely to flood water during the monsoon when the birds become very mobile with many small flocks flying over my garden. Maximum flock of 150 at DB in Feb. and March.

Anhinga rufa (Daudin),
DARTER

Those recorded at DB as detailed in my previous paper are the only records in the area, apart from those in the cormorant colony in Calcutta zoo.

Ardea cinerea Linnaeus,
GREY HERON
DB was the main haunt where it was present throughout the year except during June and July. Maximum of 12 on two occasions in Feb./March 1970. Also recorded twice from AW and from the train to Calcutta.

Ardea purpurea Linnaeus,
PURPLE HERON
One at a jheel beside the road to Suri on 19.i.69 was the only record away from DB where it was probably resident with a maximum of 6 in one day.

Ardeola striatus (Linnaeus),
LITTLE GREEN HERON
Only one further record added to those in my earlier paper was again at DB on 16.i.71. One of the first species I encountered in India, one being seen beside the canal on the way from Dum Dum airport on the day of my arrival on 10.i.68. It was never seen there again.

Ardeola grayii (Sykes),
POND HERON
An abundant resident to be found on almost every bit of water from large lakes to the smallest puddles. Very mobile during the monsoon when often seen flying over my bungalow.

Bubulcus ibis (Linnaeus),
CATTLE EGRET
An abundant resident in both wet and dry areas, even entering sal jungle. Flocks of up to 50 in favoured localities. Often seen flying over my bungalow or walking on the road outside. Of about 600 egrets to be seen from the train on a typical trip to Calcutta during the monsoon, about 2/3 appeared to be Cattle Egrets. Aquisition of breeding plumage was noted in April.

Egretta alba (Linnaeus),
LARGE EGRET
8 or 10 present at DB throughout the year. Also recorded twice at AW in Feb. and 1 or 2 recorded on most train journeys to Calcutta.

Egretta intermedia (Wagler),
SMALLER EGRET
Status much as Large Egret but about twice as numerous and more likely to be found at roadside jheels and flooded paddy.

Egretta garzetta (Linnaeus),
LITTLE EGRET
Abundant resident second in numbers to Cattle Egret but more confined to wet habitats such as DB and AW. Widespread at jheels and flooded paddy during the monsoon. About 1/3 of the egrets seen from the train to Calcutta were this species. Often seen passing over my garden.

Nycticorax nycticorax (Linnaeus),
NIGHT HERON
Principally a monsoon visitor from May to September with 50+ mostly immatures at DB with much commuting to and fro over my bungalow at dusk. Outside this season, recorded at Messenjore Dam on 23.iii.69 and a single bird over my bungalow on 26.ii.70.

Ixobrychus cinnamomeus (Gmelin),
CHESTNUT BITTERN
Records at DB, *c.* 6, now extended from May to September. About a dozen records on floodwater and paddy during the monsoon.

Ixobrychus sinensis (Gmelin),
YELLOW BITTERN
Unlike the previous species never recorded away from DB where the status remains unchanged; 12+ from April to August.

Dupetor flavicollis (Latham),
BLACK BITTERN

Another monsoon bird at DB from May to September with 7 or 8 on 31.v.70. 5 or 6 records of single birds out in the countryside during June and July suggests some dispersion.

Ibis leucocephalus (Pennant),
PAINTED STORK

The single immature at DB on 17.iii.68 as given in my previous paper remains the only record for the area.

Anastomus oscitans (Boddaert),
OPENBILL STORK

Common resident recorded in every month of the year with a breeding colony in a village off the road near Saltora. Flocks of 90 to 100 recorded near Saltora on 18.vi.69, near the DVC farm on 17.viii.69 and at DB on 28.iii.70 and 18.vi.70. 10 to 20 was the more usual flock size but singles and pairs by no means uncommon. Between 10 and 30 recorded on most journeys to Calcutta. 18 records of varying numbers flying high over my garden.

Ciconia episcopus (Boddaert),
WHITENECKED STORK

Odd pairs thinly distributed over the countryside but a flock of 10 on irrigated paddy at the DVC farm on 2.ii.68 was unusual. Most records from January to May. Not recorded in June, July, November or December.

Leptoptilos dubius (Gmelin),
ADJUTANT

One beside the road to Jamshedpur in Bankura district with other storks and egrets on 25.vii.70.

Leptoptilos javanicus (Horsfield),
LESSER ADJUTANT

One bird at DB on 23.ii.69 was the only record.

Threskiornis melanocephala (Latham),
WHITE IBIS

A monsoon visitor with 7 records from June to August at DB or in flooded paddy. Maximum of 7 seen from the train to Calcutta on 20.vii.68.

Pseudibis papillosa (Temminck),
BLACK IBIS

One bird seen from the train to Calcutta on 2.v.68.

Anser indicus (Latham),
BARHEADED GOOSE

4 at DB on 17.iii.68.

Dendrocygna javanica (Horsfield),
LESSER WHISTLING TEAL

Present at DB throughout the year with numbers building up to a peak at the end of the dry season with approx. 3000 on 18.iv.70 and 6.iii.71. Spreads out to jheels and floodwater during the monsoon with many small flocks passing over my garden. 320 seen from the train to Calcutta on 17.vi.69.

Dendrocygna bicolor (Vieillot),
LARGE WHISTLING TEAL

Possibly overlooked amongst the previous species but the only definite record was a flock of 7 or 8 passing over my bungalow on 9.vi.68. Identified by white upper tail coverts and more ponderous wing beats.

Tadorna ferruginea (Pallas),
RUDDY SHELDUCK

Common winter visitor to sandy river beds

at DB and AW, usually upto 25 but 35 at DB on 16.i.71 and an exceptional 82 on the lake at DB on 11.i.69. Also recorded on the lake at Topchanchi on 10.iii.68 and a single bird flying over my garden on 20.i.69.

Anas acuta Linnaeus,

PINTAIL

Even the large numbers mentioned in my previous paper were surpassed in 1971. From about 3000 at the beginning of the year there were 4500 on 16.i.71, 11000 to 12000 on 23.i.71, 15000 on 7.ii.71 and *c.* 18000 on 14.ii.71. Three weeks later numbers had dropped to *c.* 6000. A flock of between 100 and 200 flying northwards over my bungalow on 11.iii.71 may be evidence for my earlier suggestion that this is a pre-migration gathering. The apparent yearly increase in peak numbers is believed to be a true effect because, despite the short duration of the peak, coverage was fairly regular at the critical season.

The species was also recorded at AW and Topchanchi.

Anas crecca Linnaeus,

TEAL

Another species where 1971 numbers exceeded those recorded previously with *c.* 1000 on 28.i.71, 7.ii.71 and 14.ii.71. Also recorded at Topchanchi on 25.i.70.

Anas platyrhynchos Linnaeus,

MALLARD

No further record to add to the 4 at DB on 23.xi.69 reported in my previous paper.

Anas strepera Linnaeus,

GADWALL

Numbers at DB during November and December 1970 were at or near the previous maximum of 200 but this increased to 500 on 16.i.71 and 1000 from 23.i.71 to 14.ii.71. The latest date of the season was 4 on 18.iv.70. Also recorded at AW on 23.xi.69.

Anas penelope Linnaeus,

WIGEON

Unlike other surface feeding ducks there was no increase in numbers in 1970/1971, the maximum again being 25. Only recorded at DB.

Anas querquedula Linnaeus,

GARGANEY

Recorded upto April at DB when 150 still present on 18.iv.70. Numbers during the 1970/71 winter built up from 23 on 15.xi.70 to *c.* 500 on 7.ii.71.

Anas clypeata Linnaeus,

SHOVELLER

Only at DB. Maximum numbers up from the previous 60 to *c.* 100 in early February 1971.

Netta rufina (Pallas),

REDCRESTED POCHARD

All at DB with two more records bringing the total to five. The Dec./Jan. season extended to February and March with 2 birds on 28.iii.70 and 7.ii.71.

Aythya ferina (Linnaeus),

POCHARD

Two more records of 12 on 23.xi.70 and 20 on 7.ii.71 brings the total number of records at DB to six. Its status in Durgapur does not reflect the comment in the HANDBOOK that it is one of the commonest diving ducks, that position being held by the Tufted Duck.

Aythya nyroca (Goldenstadt),
WHITE-EYED POCHARD

The previous two records at DB were doubled with 15 on 16.i.71 and 10 on 7.ii.71.

Aythya fuligula (Linnaeus),
TUFTED DUCK

The commonest diving duck being a regular winter visitor to DB from November to April with a peak of 200 in February and March. Two out of season records with 1 on 2.vi.68 and 4 males and 1 female on 1.viii.70. Unlike the surface feeding ducks diving ducks did not show any dramatic increase in numbers in 1970/71 compared with previous years.

Nettapus coromandelianus (Gmelin),
COTTON TEAL

DB was the headquarters for the species in the area with numbers reaching a maximum of 150 in March. Numerous small parties during the monsoon when it spread out to jheels and floodwater. Courtship flights seen in May.

Sarkidiornis melanotos (Pennant),
COMB DUCK

An irregular winter visitor to DB, quite common in some seasons and almost absent in others. Only two more records of 11 birds in February 1971. 1969/70 appears to have been a particularly good year.

Elanus caeruleus (Desfontaines),
BLACKWINGED KITE

Quite common, recorded in every month of the year with 3 together on one occasion. I can see no grounds for considering the bird crepuscular, all my observations being in broad daylight. Most records were of birds over paddyfields and scrub outside my office. Also seen quite frequently between Panagarh AW.

Pernis ptilorhyncus (Temminck),
HONEY BUZZARD

A total of nine records in January, February, March, August and September, three of these being birds flying over my garden. The others were over open country, particularly the better wooded areas such as Maithon and Messanjore Dam.

Milvus migrans (Boddaert),
BLACK KITE

Abundant resident augmented by winter visitors showing more prominent carpal patches. Several birds over my garden daily.

Haliastur indus (Boddaert),
BRAHMINY KITE

A single bird could usually be found on every visit to DB or AW. Much more widespread over jheels and flooded paddy during the monsoon when upto 6 could be seen in an afternoon. 1 over my garden on 30.ix.68.

Accipiter badius (Gmelin),
SHIKRA

Apart from 1 record at Dishergarh on 21.xii.69, the remaining 15 records were of single birds over or near my garden concentrated in the period November to March but also seen in June and July.

Accipiter trivirgatus (Temminck),
CRESTED GOSHAWK

1 at Topchanchi on 26.i.70. By coincidence what appeared to be a large accipiter flew past my office on the following day but was not identified for certain.

Buteo rufinus (Cretzschmar),
LONGLEGGED BUZZARD

A bird watched at close range on the ground beside the road between Bolpur and

Katwa remained a puzzle for a long time but when my notes and sketches could be compared with detailed descriptions it proved to be an immature pale phase of this species. Another *Buteo* at DVC farm on 26.i.68 was probably this species.

Butastur teesa (Franklin),
WHITE-EYED BUZZARD

Apart from one record in July all other records were for the dry season from October to May. A bird of the better wooded areas and sal jungles, with 15 records of birds over my garden or adjacent parts of the colony.

Spizaetus cirrhatus (Gmelin),
CRESTED HAWK-EAGLE

5 records between June and September 1968 of birds over my garden or the surrounding jungle. After an absence in 1969 another 5 records spread evenly throughout in 1970 with 1 more on 2.i.71.

Hieraaetus fasciatus (Vieillot),
BONELLI'S EAGLE

1 adult at AW on 16.ii.69.

Hieraaetus pennatus (Gmelin),
BOOTED EAGLE

Single birds over my garden on 14.ii.68 and 3.vii.70. A more problematical dark phase bird near the DVC farm on an unrecorded date.

Aquila heliaca Savigny,
IMPERIAL EAGLE

1 at the DVC farm on 21.i.68 identified by its light coloured shoulder patches.

Aquila rapax (Temminck),
TAWNY EAGLE

The aquila eagles are notoriously difficult to identify with various immature plumages and colour phases but more recent published literature and field guides have thrown some light on the problem. Unless there was good reason for thinking otherwise aquilas were attributed to this species although the only aquila listed by Lowther for the Dhanbad district was *A. pomerina* Lesser Spotted Eagle. 1 near the road to Dubrajpur on 24.i.68, 1 low over the road between Panagarh and Ilam Bazar in Feb. 1968 (actual date not recorded) had its identification confirmed with the aid of a colour photograph taken with a 450 mm telephoto lense and 1 at AW on 5.i.69. The only monsoon record of an *Aquila* sp. was of one being mobbed by terns over the Ajoy river on 16.vi.68, which may have been a Lesser Spotted. Apart from this record all the others were confined to January-March with the majority in 1968 which was the driest period.

Aquila clanga Pallas,
GREATER SPOTTED EAGLE

1 near the Ajoy river from the Panagarh — Ilam Bazar road on 24.i.68 showing a white rump. This was about 16 km from where the Tawny Eagle was seen the same day. 1 over the lake at Topchanchi on 10.iii.68 showing the very broad wings and short tail of an immature and 1 over irrigated paddy at the DVC farm on 16.ii.69.

Ictinaetus malayensis (Temminck),
BLACK EAGLE

1 record of this unmistakable bird gliding with its characteristic slow flight along a wooded slope beside the reservoir at Messanjore dam on 23.iii.69.

Torgos calvus (Scopoli),
PONDICHERRY VULTURE

A pair seen at Maithon on most visits, a

single bird eating some offal on the office lawn on 18.xi.68 and 1 on 15.ii.70 in Bankura district near the road to Purulia.

Gyps fulvus (Hablizl),
GRIFFON VULTURE

9 records of pale *Gyps* vultures with white heads. 8 of these occurred in February, 6 of these being over my garden in 1969 and 1971. A single bird was presumably responsible for the 5 records from 6.ii.69 to 19.ii.69. The only non-February record was 1 on 5.xi.70. Grubh (1978) has indicated the difficulties of separating this species from immature Long-billed Vulture when the latter lacks its black head and neck. However I believe only Griffons could display such pale creamy white plumage as that seen on these birds.

Gyps indicus (Scopoli),
LONGBILLED VULTURE

Probably under-recorded by the 9 records spread over February, March, April, June, October and December without any discernible pattern. Single birds over my garden on 4 occasions. 3 of the other records were of 2 birds together.

Gyps bengalensis (Gmelin),
INDIAN WHITEBACKED VULTURE

Abundant resident with hardly a day going by without seeing at least one. Seen circling over my garden on numerous occasions in flocks upto 45. A steady stream heading east in ones or twos almost all day long on 1 and 2.iv.68 may suggest some seasonal movement with the monsoon.

Neophron percnopterus (Linnaeus),
EGYPTIAN VULTURE

Rather scarce in Durgapur itself with only 3 records. Commoner in Purulia District and beyond Asansol into Bihar when most excursions into these areas would produce a bird or two.

Circus cyaneus (Linnaeus),
HEN HARRIER

1 at the DVC farm on 20.i.68.

Circus macrourus (S. G. Gmelin),
PALLID HARRIER

The statement in my previous paper that the species was quite common in winter now appears to have been over optimistic. There was 1 outside my office on 15.i.68 and then 4 records between 18.xii.68 and 24.iii.69, one of these being over my garden on 4.i.69. None at all were seen in either of the next two winters. A number of female or immature harriers could not be identified as to species and this might alter the picture.

Circus melanoleucos (Pennant),
PIED HARRIER

Winter visitor with 19 records between November and March, almost half of which were at DB. More likely to be found away from water than the Marsh Harrier. A complete absence of records for the 1970/71 winter suggests this was a particularly poor year for harriers.

Circus aeruginosus (Linnaeus),
MARSH HARRIER

By far the commonest harrier and recorded in every month except May, June and July. Most numerous over the reed beds at DB with upto 4 at once, but also seen over other watery habitats such as AW, canals and jheels. 2 records of birds flying over my garden. Unlike other harriers the species maintained its numbers in 1970/71.

Circaetus gallicus (Gmelin),
SHORT-TOED EAGLE

1 hunting over the sand banks at AW on 12.v.68.

Spilornis cheela (Latham),
CRESTED SERPENT EAGLE

1 over my garden on 31.v. or 1.vi.68 and 1 over the nearby jungle on 23.i.70.

Pandion haliaetus (Linnaeus),
OSPREY

June and July remain the only months when this bird has not been seen at DB. Also several records from AW with 2 on 15.xii.68.

Falco peregrinus Tunstall,
PEREGRINE FALCON

1 at DB on 15.ix.70.

Falco subbuteo Linnaeus or **F. severus** Horsfield, HOBBY or ORIENTAL HOBBY

A falcon believed to be *F. subbuteo* from a brief glimpse as it flew over my garden on 14.v.70 but the date is very late for a supposed winter visitor. The same or a similar bird was seen over the nearby jungle six weeks later on 26.vi.70.

Falco chicquera Daudin,
REDHEADED MERLIN

1 clearly seen beside DB on 29.xi.70. A small blue-grey falcon seen disappearing into a Borassus palm near my office 21.iii.68 was probably this species.

Falco naumanni Fleischer,
LESSER KESTREL

A party of 4 birds outside my office on 8.xii.69 showing the characteristic blue-grey wing coverts. Another group of 3 at Dishergarh on 21.xii.69.

Falco tinnunculus Linnaeus,
KESTREL

A winter visitor to the open countryside from early October to the end of March. 17 records in all with 1 over my garden on 29.iii.69, the latest date.

Francolinus francolinus (Linnaeus),
BLACK PARTRIDGE

4 records between 13.iv.68 and 2.vi.68 of a single bird in scrub habitats varying from sal jungle to dry riverside scrub downstream of DB. 1 seen from a train to Calcutta on 22.ix.70.

Francolinus pondicerianus (Gmelin),
INDIAN GREY PARTRIDGE

11 records spread throughout the year but not March, November or December. Usually 2 birds but 4 together on one occasion at DB. The grassy area with clumps of dense bushes beside the approach road to my office was a favourite haunt.

Coturnix coromandelica (Gmelin),
RAIN QUAIL

2 beside the road on the way to Ragunathpur on 9.vi.70. On several other occasions quail-like birds, either singly or in pairs, were seen scuttling across roads but were not specifically identified.

Perdicula asiatica (Latham),
JUNGLE BUSH QUAIL

A covey in an area of long grass and lantana scrub beside the road to Bishnupur on 18.ii.68. No other record nearer than Hazaribagh N.P.

Galloperdix lunulata (Valenciennes),
PAINTED SPURFOWL

No first hand evidence but friends reported birds seen quite often in the early morning on

the road to Maithon Yacht Club. This ran along the side of a wooded rocky hill and would appear an ideal habitat. Lowther found the bird at Topchanchi.

Gallus gallus (Linnaeus),
RED JUNGLE FOWL

A call was heard from deep in the sal jungle on 18.v.68 but nothing could be found on following it up. An early rising neighbour reported birds visiting his garden in the early mornings in April 1969 and two tail feathers had been picked up.

Turnix tanki Blyth,
YELLOWLEGGED BUTTON QUAIL

1 on fallow land at AW on 30.iii.69.

Turnix suscitator (Gmelin),
BUSTARD-QUAIL

The commonest of the small quail-like birds of the area and probably more numerous than the 10 records suggest, being found in most areas with a mixture of scrub and open ground, a habitat becoming increasingly widespread as the woodland disappeared. 1 bird scuttled across the road and into my garden on 21 viii.69.

Amaurornis phoenicurus (Pennant),
WHITEBREASTED WATERHEN

Quite common along the canal bund road to AW when they would emerge from the canal-side vegetation in the evening. Found in flooded paddy and even the office lawn during the monsoon. 1970 records at DB were confined to May but 7-8 on 31st was an unusually large number.

Gallicrex cinerea (Gmelin),
WATERCOCK

Only recorded from DB during the monsoon, at least 2 birds but none seen in 1970.

Gallinula chloropus (Linnaeus),
MOORHEN

The March-August pattern at DB continued in 1970 but with increased numbers of 20-30 at the end of May. An adult with chicks on 1.viii.70. Also seen at a roadside jheel near Ragunathpur on 16.xii.70 (the only winter record) and from the train to Calcutta on 7.iv.69.

Porphyrio porphyrio (Linnaeus),
PURPLE MOORHEN

DB was the only place where the species was recorded and the status remained unchanged from that reported previously, i.e. upto 7-8 from March to August.

Fulica atra Linnaeus,
COOT

Wintering in small numbers at DB but maximum in 1970/71 was only 3. The solitary record on 2.vi.68 at DB remains the only summer record.

Hydrophasianus chirurgus (Scopoli),
PHEASANT-TAILED JACANA

Common resident at DB with upto 200 in April. Recorded in every month except October (but only two visits in three years at that time). Could also be found on suitable marshy jheels but less likely than next species. Nuptial display was noted in May and birds began moulting out of breeding dress in mid-September. Thus they could be more retiring and less likely to be seen in October.

Metopidius indicus (Latham),
BRONZEWINGED JACANA

Common and widespread resident on jheels and wet habitats, but less gregarious than the previous species. 24 were recorded from the train to Calcutta on 7.iv.69. Numbers con-

centrated at DB during the hot weather with 50-60 in March and April. Smaller numbers recorded there throughout the year except October.

Vanellus cinereus (Blyth),
GREYHEADED LAPWING
1 at DB on 18.iv.70.

Vanellus indicus (Boddaert)
REDWATTLED LAPWING
A common resident in wet areas becoming more mobile during the monsoon. DB and AW were regular haunts but also found on jheels and flooded paddy. 2 records of birds flying over my garden in June.

Vanellus spinosus (Linnaeus),
SPURWINGED LAPWING
1 or 2 records of single birds on the sand banks at AW in January and February in each winter.

Vanellus malabaricus (Boddaert),
YELLOW-WATTLED LAPWING
Usually a pair or two on the dry sandy areas at AW from January to May. Maximum number was 6 on 3.i.71. A pair also found an area of the adjacent factory compound used for dumping foundry slag to their liking producing the only June record on 4.vi.70. 1 downstream of DB on 11.iv.70 was the only record there.

Pluvialis squatarola (Linnaeus),
GREY PLOVER
1 downstream of DB on 24.iii.68 and 1 on fallow land in Bankura district about 1 or 2 km south of DB on 29.ix.68.

Pluvialis dominica (P. L. S. Muller),
LESSER (or EASTERN) GOLDEN PLOVER
The situation at DB remained unchanged in 1970/71 with upto 50 from December to April, latest date 18th. Also at AW with 30 on 30.iii.69.

Charadrius dubius Scopoli,
LITTLE RINGED PLOVER
A dry season bird of sandy rivers at DB or AW, usually 6 or 7 but upto 10 or 12 at times. Also seen on the Ajoy river on 16.vi.68. Display flight and mobbing recorded in January.

Charadrius alexandrinus Linnaeus,
KENTISH PLOVER
A common dry season bird of sandy river beds at DB or AW, maximum number was 62 on 5.xii.70.

Charadrius placidus J. E. Gray or **C. hiaticula** Linnaeus,
LONGBILLED RINGED PLOVER or RINGED PLOVER
1 at DB on 16.iii.69, probably the former. See comments in my earlier paper.

Charadrius mongolus Pallas,
LESSER SAND PLOVER
Two more records at DB of 3 on 30.ix.68 and 1 on 11.i.69 omitted from my earlier paper bring the total to five.

Numenius arquata (Linnaeus),
CURLEW

Numenius phaeopus (Linnaeus),
WHIMBREL
One more record of 1 at DB on 27.ix.70, again flying SE like the 2 previous records, and again the preference was for Whimbrel rather than Curlew.

Tringa erythropus (Pallas),
SPOTTED REDSHANK

A winter visitor from November to April at DB or AW with an exceptionally early record of 1 on flooded paddy near the DVC farm on 31.viii.68. The latest date was 2 at AW 21.iv.68. A flock of 8 or 9 flew over my garden on 23.iii.70. The supposedly commoner Redshank *T. totanus* remained as elusive as ever and I never saw one in W. Bengal, the nearest being 1 in Madhya Pradesh between Jabulpur and Katni.

Tringa stagnatilis (Bechstein),
MARSH SANDPIPER

The only additional observation to add to the 8 records at DB in my previous paper was 1 at AW on 23.xi.69. None at all were seen in the 1970/71 winter.

Tringa nebularia (Gunnerus),
GREENSHANK

Common winter visitor to the Damodar river and suitable wet areas such as flooded paddy. The earliest date was 1st August and the latest was 18th April. The usual number was 5 or less but upto 20 on occasions.

Tringa ochropus Linnaeus,
GREEN SANDPIPER

Whilst DB and AW were the main haunts, it was the small sandpiper most likely to be found in wet ditches and jheels. Earliest date 14th August and latest 18th April. Common and often seen in small groups of upto 5.

Tringa glareola Linnaeus,
WOOD SANDPIPER

DB was the birds favourite haunt but also found regularly at AW and occasionally elsewhere. One of the earliest waders to arrive being found on flooded paddy on 27th July with 5 August records of upto 15 birds. The latest date was 21st April. This species was much commoner than either Green or Common Sandpipers.

Tringa terek (Latham),
TEREK SANDPIPER

A small sandpiper slightly larger than Common Sandpiper with similar bobbing action but with upturned bill and yellow legs was seen at DB on 1 or 7.ix.68 was omitted from my previous paper because the bill did not seem long enough or show a yellow base. However subsequent experience of the species and comparison with more detailed descriptions confirmed the identification.

Tringa hypoleucos Linnaeus,
COMMON SANDPIPER

Common winter visitor with DB and AW its main haunts but also found on jheels and wet paddy. Earliest 31st August, latest 18th April.

Gallinago stenura (Bonaparte),
PINTAIL SNIPE

Some birds flushed from dry grass and lantana scrub beside the road to Bishnupur on 18.ii.68 was the only occasion when I felt justified in identifying this species. It was a most un-snipe like habitat (the same place as the Jungle Bush Quail). The published information on the separation of Pintail and Common Snipe in the field was not available until after I left India.

Gallinago gallinago (Linnaeus),
FANTAIL (or COMMON) SNIPE

Recorded at DB in every month except June and July. More numerous in winter when upto 15. Also at AW on 15.xii.68. Mobile during the monsoon when 2 birds flew over my garden on 6.viii.68 and 1 on 19.ix.70.

Gallinago minima (Brunnich),
JACK SNIPE
1 at DB on 3.i.70 was the only record.

Calidris canutus (Linnaeus),
KNOT
The identification of 1 at DB on 3.i.70 mentioned in my previous paper received further confirmation in King *et al.* (1975) who state that the Eastern (or Great) Knot *C. tenuirostris* shows clear white upper tail coverts whereas my notes refer to this area being greyish white contrasting little with the back, typical of Knot.

Calidris minuta (Leisler),
LITTLE STINT
Mainly at DB from September to April, also at AW with a latest date of 21.iv.68. Less frequent than previously during the 1970/71 winter.

Calidris temminckii (Leisler),
TEMMINCK'S STINT
The most numerous wader. A very common winter visitor to the river beds with early arrivals on flooded paddy, earliest 31st August. The latest date was 21st April, with a probable at AW on 12.v.68. The largest concentrations were downstream of DB.

Calidris subminuta (Maddendorff),
LONGTOED STINT
1 at AW on 7.iii.68. Several other observations of birds among flocks of Little and Temminck's Stints were probably this species.

Calidris testacea (Pallas),
CURLEW SANDPIPER
1 at DB on 13.ix.70.

Philomachus pugnax (Linnaeus),
RUFF
A small flock seen at AW several times in Jan./Feb. 1968 but I can find written evidence for only one subsequent record on 15.xii.68. However I have distinct recollections of greater regularity there. There were no additions to the 2 records at DB but this variable species was probably the origin of a number of unidentified waders.

Rostratula benghalensis (Lannaeus),
PAINTED SNIPE
The office drain provided a small area of wet paddy which supported 3 or 4 during April-June 1968. The only records were from DB in March-April 1969. These were all hot weather records when wet habitats were otherwise scarce.

Himantopus himantopus (Linnaeus),
BLACKWINGED STILT
A flock on a marshy jheel between Bolpur and Katwa in February 1968 and on flooded paddy near the DVC farm on 31.viii.68 were the only records away from DB. No more records of large flocks there with a maximum of only 7 between 1.iii.70 and 23.v.70. The high rainfall and river flow in September 1970 scoured away much of the shallow areas on the upstream side of DB which was their favourite haunt.

Burhinus oedicnemus (Linnaeus),
STONE CURLEW
2 in the scrub on the north side of the GT road on 6.iv.68 in the area which was eventually to become the town centre and 3 birds flushed from the edge of the lake at Maithon on 24.i.71.

Cursorius coromandelicus (Gmelin),
INDIAN COURSER

3 on a stabilised sandbank below AW on 21.i.68. It should be noted that this was during a very dry spell.

Glareola lactea Temminck,
SMALL INDIAN PRATINCOLE

Much scarcer at DB in 1970/71 with only two more records, both of single birds, 1 on the unseasonable date of 15.ix.70 and 1 on 23.i.70. A small flock at AW on 5.i.69 and 4.i.70. 2 records of 1 and 4 birds over my garden in March 1969.

Larus argentatus Pontoppidan,
HERRING GULL

Recorded on the Hoogly at Calcutta in February.

Larus ichthyaetus Pallas,
GREAT BLACKHEADED GULL

An immature at DB on 27.xii.70 identified by its huge size and broad black subterminal tail band. It was watched in flight and through a telescope at rest.

Larus brunnicephalus Jerdon,
BROWNHEADED GULL

3 at AW on 12.v.68 and 1 at DB in April 1968 suggests spring migration from the Calcutta area where they winter along with Herring and Blackheaded Gulls. Latest date at Calcutta was 26th April.

Larus ridibundus Linnaeus,
BLACKHEADED GULL

Quite common on the Hoogly in winter at Calcutta in January and February.

Chlidonias hybrida (Pallas),
WHISKERED TERN

The commonest and most numerous tern of the sandy rivers at DB and AW, also Ajoy river. It could also be found in flocks over flooded paddy particularly when attracted by agricultural operations. Display noted at DB in April and birds in juvenile plumage in September. 1 over my garden on 30.v.69 and several possibles.

Gelochelidon nilotica (Gmelin),
GULLBILLED TERN

2 at DB on 5.xii.70. It is a matter of conjecture whether there was any connection with the record of the Great Blackheaded Gull three weeks later.

Sterna aurantia J. E. Gray,
INDIAN RIVER TERN

April to August at AW and March to October at DB. Usually 1 or 2, occasionally 3 but 7-8 at DB on 1.viii.70 was exceptional. Like most other terns it foraged over flooded paddy during the monsoon when seen over my garden on 5.viii.68.

Sterna hirundo Linnaeus,
COMMON TERN

A rather scarce winter visitor. 1 at AW on 23.xi.69 was in line with 3 previous November/December records at DB but 1 at DB on 1.viii.70. was outside this pattern.

Sterna acuticauda J. E. Gray,
BLACKBELLIED TERN

This bird preferred sand banks to marshes and was seen more frequently at AW than DB, being seen in every month except August and September. Seen carrying fish at DB on 14.iv.68 which could have been nuptial display and a pair had 2 small young at AW

on 12.v.68. Some dispersal during the monsoon with 6 or 7 outside my office on 14.vii.69. April and May records of birds flying over my garden.

Sterna albifrons Pallas,
LITTLE TERN
A seventh record at DB on 11.iv.70 was added to the previous 6, all between March and June.

Treron bicincta (Jerdon),
ORANGEBREASTED GREEN PIGEON
1 at Topchanchi on 25.i.70.

Streptopelia decaocto (Frivaldszky),
COLLARED DOVE
Much less numerous than the Spotted Dove but still quite common in the Durgapur area. More a bird of the open countryside but could be found in sal jungle in March-May. Rather scarce in my garden to start with but a regular visitor by 1970, presumably an effect of increased de-forestation. Usually outnumbered the Spotted Dove in counts made from the train to Calcutta.

Streptopelia tranquebarica (Hermann),
RED TURTLE DOVE
Apart from 1 on the office lawn on 15.vii.68, only seen at AW between March and August with a maximum of 4.

Streptopelia chinensis (Scopoli),
SPOTTED DOVE
An abundant resident in gardens and sal jungle. Display noted in February and September and nesting took place in my garden in April. Flocks of upto 14 recorded.

Streptopelia senegalensis (Linnaeus),
SENEGAL (or LAUGHING, or LITTLE BROWN) DOVE
Thinly distributed over the countryside and sal scrub. Mostly avoided gardens but appeared in mine on 2 occasions. The telegraph wires along the approach road to my office were a favourite haunt. Apparently resident but December records rather sparse.

Columba livia Gmelin,
ROCK PIGEON
Common resident, probably all of feral origin but a small proportion resembled the true wild type.

Psittacula eupatria (Linnaeus),
LARGE INDIAN PARAKEET
Recorded at Topchanchi on 10.iii.68. The species is included in Lowther's list of breeding birds of Manbhum around Dhanbad.

Psittacula krameri (Scopoli),
ROSERINGED PARAKEET
A common resident but nothing like so abundant as it is around Delhi and Agra. Flocks of about 20 at DB and AW. A fairly frequent visitor to my garden particularly during the monsoon to raid the sweet corn *Zea mays.*

Psittacula cyanocephala (Linnaeus),
BLOSSOMHEADED PARAKEET
An influx of 3 or more into my garden in January 1971 were suspected to be of captive origin. It was a favourite cage bird and a number of ex-patriates had recently left. Prior to this birds had appeared in my garden on 18.vi.68, 7.ii.69 and 3 on 10.ii.69. It was quite common at Topchanchi.

Clamator jacobinus (Boddaert),

PIED CRESTED CUCKOO

A common monsoon visitor whose arrival dates in the three years were 1st June, 4th June and 31st May. Most records were from my garden but seen quite frequently elsewhere. The latest date for an adult was 22nd September but young birds were recorded on 5th and 6th October in different locations. Rather fewer records in 1970 compared with previous years.

Cuculus varius Vahl,

COMMON HAWK-CUCKOO

Very common, probably resident but not in evidence when silent in November and December. 1 January sight record. Heard in and around my garden in every month from February to October.

Cuculus micropterus Gould,

INDIAN CUCKOO

Probably only a monsoon visitor to my garden and surrounding area but could be over looked when silent. Garden records during 12.vi.68-14.vii.68 and 25.ii.69-12.vii.69 2 other records on 29.ix.68 and 6.x.68, the later being a juvenile at AW.

Cacomantis sonneratii (Latham),

BANDED BAY CUCKOO

1 beside the road near Ragunathpur on 13.ii.70 and 1 at DB on 1.iii.70.

Cacomantis merulinus (Scopoli),

PLAINTIVE CUCKOO

Probably resident in small numbers, occurring in gardens and surrounding area from April to October and in reed beds at DB during November to January. The only records in 1969 were at DB in January.

Surniculus lugubris (Horsfield),

DRONGO-CUCKOO

1 at AW on 8.ix.68.

Eudynamys scolopacea (Linnaeus),

KOEL

Very common resident of gardens, jungle and almost any grove of trees. Of almost daily occurrence in my garden particularly favouring the fruits of the *Muntingia*.

Centropus sinensis (Stephens),

COUCAL

Common resident in gardens and country with suitable cover. Recorded in my garden in every month of the year.

Tyto alba (Scopoli),

BARN OWL

1 in the car headlights on the road from Ragunathpur after dark on 19.xii.69. No other owl would have looked so white in the circumstances.

Otus bakkamoena Pennant,

COLLARED SCOPS OWL

Heard calling at night in or near my garden on 5 occasions; 14.i.68, 25.vi.68, 3.vii.68, 25.vii.68 and 30.ix.70.

Glaucidium radiatum (Tickell),

JUNGLE OWLET

1 at Topchanchi on 25.i.70.

Athene brama (Temminck),

SPOTTED OWLET

Probably much overlooked. A pair in the avenue of large trees at AW on every visit during January-May 1968 but not subsequently: 1 perched in a tree near the colony entrance on the GT road in January 1968 and another in a roadside tree between Ragunathpur and Purulia on 29.xi.68.

? Strix ocellata (Lesson),

OWL

The silhouette of a large owl was seen flying over my garden after dark on 10.ix.68. A couple of weeks later a neighbour reported seeing an owl about 45 cm (18 in.) tall standing in a colony road illuminated by his ear headlights. It was not white like a Barn Owl. Mottled Wood Owl appears to be the likliest identification.

Caprimulgus macrurus Horsfield,

LONGTAILED NIGHTJAR

Fairly common in sal jungle and other areas which could provide dense cover, with a rather variable pattern of occurrence from year to year. 9 records between 5.iv.68-23.ix.68, 3 between 28.ii.69-5.vi.69 and 9 between 29.xii.69-3.iv.70. Birds appeared in my gardens on several occasions to hunt termite swarms with Little Nightjars and drongos at dusk. The continued destruction of the sal jungle must adversly affect the species.

Caprimulgus asiaticus Latham,

INDIAN LITTLE NIGHTJAR

A common bird but not in evidence during November-December. A regular garden visitor and it would call for hours at a time from my bungalow roof, January to April being the most vocal period.

Apus affinis (J. E. Gray),

HOUSE SWIFT

Very common over the area, including my garden, but absent from October to January.

Cypsiurus parvus (Lichtenstein),

PALM SWIFT

A very common resident throughout the area and recorded over my garden in every month, the largest numbers being about 100 in February.

Hemiprocne longipennis (Rafinesque),

CRESTED TREE SWIFT

Several at Topchanchi on 12.i.69 where it was also found by Lowther.

Ceryle rudis (Linnaeus),

LESSER PIED KINGFISHER

Resident pairs at DB (2 or 3) and AW. Could also be seen at track side jheels on most train journeys to Calcutta.

Alcedo atthis (Linnaeus),

COMMON (or SMALL BLUE) KINGFISHER

Scarce winter visitor, the earliest being 1 at a roadside ditch near the DVC farm on 28.ix.68. Otherwise at AW or DB with 4 records in January-March.

Halcyon smyrnensis (Linnaeus),

WHITEBREASTED KINGFISHER

Common but thinly distributed resident from waterside habitats at DB and AW to dry country. The roadside wires on the way to my office were a favourite haunt and twice seen from my garden.

Merops philippinus Linnaeus,

BLUETAILED BEE-EATER

Quite common summer visitor to rivers, jheels and flooded paddy. Earliest date 30th March and latest 29th September. Several records during the monsoon of upto 6 birds over my garden.

Merops orientalis Latham,

LITTLE GREEN BEE-EATER

Common resident in a wide variety of habitats with small parties flying or hunting over my garden in most months.

Coracias benghalensis (Linnaeus),

INDIAN ROLLER

A common bird of open countryside with upto 24 being counted on a train journey to

Calcutta. It would occasionally penetrate into more wooded areas and gardens.

Upupa epops Linnaeus,
HOOPOE

Apparently a thinly distributed resident with a winter influx. The sandy areas at AW were a favourite winter haunt with upto 4 birds. 5 records for the period April to September but over 20 for October to March. Seen in or from my garden six times; twice in February, twice in March, once in July and once in September.

Tockus birostris (Scopoli),
GREY HORNBILL

1 at Topchanchi on 26.i.70.

Megalaima zeylanica (Gmelin),
GREEN BARBET

Common only at Topchanchi. It obviously preferred the more deciduous and varied forest to the sal jungle around Durgapur. The HANDBOOK states that it straggles as far as Calcutta but the SYNOPSIS gives the eastern limit as Bihar. It would be difficult to overlook such a noisy bird if it were present and hence I would support the latter distribution.

Megalaima haemacephala (P. L. S. Muller),
CRIMSONBREASTED BARBET

A very common resident with birds' calling from almost every clump of trees. A pair took up residence in my garden in 1969 and began excavating a nest hole in a broken branch of a Gul Mohr on 2.iii.70. Fledged young were visible at the nest hole on 23.v.70 and flew shortly afterwards. The parents were excavating a new hole on 26.vii.70.

Jynx torquilla Linnaeus,
WRYNECK

A common winter visitor, regular haunts being my garden, canal side scrub at AW and piles of facing stones left along the bund road at DB. The earliest date was 15th September and the latest 14th April.

Dinopium benghalense (Linnaeus),
LESSER GOLDENBACKED WOODPECKER

Fairly common, apparently more so than the Yellowfronted Pied Woodpecker but this may be because the larger species is more conspicuous and more ready to come out in the open. A permanent feature of my garden from November 1970 after only 2 previous records.

Picoides mahrattensis (Latham),
YELLOWFRONTED PIED WOODPECKER

A pair became resident in my garden from December 1969 until my departure after only 3 records in the two previous years. 3 birds indulging in a nuptial chase on 20.ii.71. The pair started to excavate a nest hole in a rather half-hearted fashion in a large tree in my garden, and it was surprising to find the Lesser Goldenbacked Woodpecker taking turns from time to time when they got bored, with the Blossomheaded Parakeets keeping an eye on overall progress. Unfortunately I left the country before this intriguing situation was resolved.

Picoides nanus (Vigors),
BROWNCROWNED PIGMY WOODPECKER

1 in my garden on 9.iv.68.

Chrysocolaptes lucidus (Scopoli),
LARGER GOLDENBACKED WOODPECKER

A goldenbacked woodpecker with a red rump was seen beside the GT road about 15 km outside Calcutta on 22.viii.70 and was most probably this species.

Pitta brachyura (Linnaeus),
INDIAN PITTA

The evidence for this species is somewhat circumstantial. My notes for 21.iii.68 refer to an unidentified loud whistle written down as 'ke-weEEp'. On 22.iii.68 my wife reported a strange bird (like a Nuthatch *Sitta europa* with long legs) on our bungalow lawn. Finally on 30.iv.68 I had a fleeting glimpse of a medium sized passerine with rounded wings, white wing patches and dipping flight flying across my lawn. It is difficult to find a conclusion other than a Pitta to fit these facts.

It is a species recorded by Lowther (1949) as nesting in Manbhum.

Mirafra javanica Horsfield,
SINGING BUSH LARK

A pair of these larks were apparently resident in scrubby cultivation just upstream of AW. Probably overlooked elsewhere and was not specifically identified unless the white outer tail feathers could be seen.

Mirafra assamica Horsfield,
BUSH LARK

Mirafra erythroptera Blyth,
REDWINGED BUSH LARK

Whistler says these two species may be separated by the former being heavier, darker and greyer. However opportunities for close inspection or direct comparison were few and the species have been taken together. One or both were quite common in thin scrub or poor cultivation and recorded in all months except May and November. Most visits to AW or DB would find a bird or two on the road or wires.

Eremopterix grisea (Scopoli),
ASHYCROWNED FINCH-LARK

Common in thin scrub and poor cultivation. During the monsoon flocks occur in drier areas. On 14.viii.69. my notes refer to frequent flocks of 12-15 birds on a journey to Ragunathpur. Probably resident but no records from its usual haunts during November-January.

Ammomanes phoenicurus (Franklin),
RUFOUSTAILED FINCH-LARK

The only place where this species was seen was the dam at Maithon where it was quite regular on the sloping face of the dam near the water's edge.

Calandrella cinerea (Gmelin),
SHORT-TOED LARK

One in the stock yard of the works compound on 1.i.70. This is not as odd as it might seem because the area in question was surfaced with coarse gravel with a few weeds, hence resembled a small stony desert.

Calandrella raytal (Blyth),
SAND LARK

Common on the sand banks below DB and AW. Display seen in October and a nest with eggs in March.

Galerida sp.,
CRESTED LARK or SYKES'S CRESTED LARK

There are two records of larger larks, one in a sandy river bed beside the road to Ilam Bazar on 11.ii.68 which was definitely considered to be a species of crested lark and another downstream of DB which was distinctly larger than the Sand Larks. The HANDBOOK and the SYNOPSIS give the eastern limit of both species as Bihar.

Alauda gulgula Franklin,
EASTERN SKYLARK

Probably commoner than the comparatively

few records suggest. It appears to be a thinly distributed resident in light scrub and cultivation, areas which were not examined very thoroughly. Most car journeys would produce records of several unidentified larks, probably this species. The larks of West Bengal would benefit from a more critical inspection.

Riparia riparia (Linnaeus),
COLLARED SAND MARTIN

Scarce but probably overlooked amongst other hirundines. Only two records, 5 or 6 at DB on 14.xii.68. and a few at AW on 26.ix.70.

Riparia paludicola (Vieillot),
PLAIN SAND MARTIN

A large colony in the river bank just upstream of AW in Jan. 1968 was washed out by the monsoon floods. Another smaller colony was found about 2 km downstream of DB on 22.ii.70. Records were confined to the vicinity of the Damodar river and for the period November-May, the birds apparently departing during the monsoon.

Hirundo concolor Sykes,
DUSKY CRAG MARTIN

2 on Parasnath Hill on 10.ii.70.

Hirundo rustica Linnaeus,
BARN SWALLOW

Common and widespread winter visitor. The March gathering at DB in 1970 was only 300 strong, a tenth of previous years. Small flocks frequently seen over my garden. The earliest record was 4th August and the latest 12th May.

Hirundo smithii Leach,
WIRETAILED SWALLOW

Several at the DVC power station on 24.iv.68. Also at DB in February 1968 probably 4th. This record was overlooked in my previous paper.

Hirundo fluvicola Blyth,
INDIAN CLIFF SWALLOW

The only record other than those in my previous paper at DB was of several birds at AW on 12.v.68.

Hirundo daurica Linnaeus,
REDRUMPED SWALLOW

Winter visitor in varying numbers, earliest 26th Sept. and latest 20th April. This species preferred hunting over open area such as the DVC farm rather than the river. Several 1970 records of birds over my garden, max. 12. Some swallows seen in the vicinity of Perulia on 23.vii.70 were probably this species which Lowther recorded as a nesting species in Manbhum.

Lanius vittatus Valenciennes,
BAYBACKED SHRIKE

I obtained a photograph of a single bird at AW on a date which was not recorded but was probably during Feb. 1970.

Lanius schach Linnaeus,
BLACKHEADED SHRIKE

Apart from a single rufous backed form on the way to AW on 15.xii.70, all other records (*c.* 60) were of the black headed form. Usually seen singly but several records of 2 or 3 together. Status uncertain but probably a small resident population with a winter influx. About 2/3 of all records were for the period Nov.-Feb., 5 records for the period April-June. The birds appeared to be territorial, taking up a favoured perch where they could be seen day after day. One bird took up residence in my garden from 28.iv.70 to 13.v.70 and reappeared on 5.viii.70.

Lanius cristatus Linnaeus,

BROWN SHRIKE

A very common and widespread winter visitor to gardens and open countryside, avoiding only closed forest. Earliest date 5th Sept., latest 4th May, both being from my garden where it was almost a permanent feature except during the monsoon.

Oriolus oriolus (Linnaeus),

GOLDEN ORIOLE

A common monsoon visitor to gardens, sal jungle and countryside with trees. In 1968 birds were present from 6th April to 6th Oct. in 1969 from 6th April to mid-August and in 1970 from March to July. This is at variance with the HANDBOOK which suggests it is mainly a winter visitor to the plains with 'small numbers also resident and patchy breeding'.

Oriolus xanthornus (Linnaeus),

BLACKHEADED ORIOLE

A common resident of gardens, sal jungle and wooded country. During the monsoon it tended to surrender the gardens to the Golden Oriole and was then found mainly in sal jungle.

Dicrurus adsimilis (Bechstein),

BLACK DRONGO

Common resident of gardens, scrub and open country, penetrating sal jungle at times. Breeding occurred during the monsoon with fledged young appearing in July and August. Termite flights would attract parties of 20-30 to my garden.

Dicrurus leucophaeus Vieillot,

GREY DRONGO

The specific identification of all drongos in winter would be a time consuming process, and the species was only readily identified in assemblies with Black Drongos after termite swarms when smaller size and greyer plumage could be compared. The speed with which several birds could arrive at a termite swarm in my garden suggests it may have been commoner than the four records, all January-April, suggest.

Dicrurus caerulescens (Linnaeus),

WHITEBELLIED DRONGO

A winter visitor to my garden with 15 records between 22.xi.69 and 22.ii.70. It, or another, reappeared the following winter with 8 records between 19.xi.70 and 21.ii.71, a surprising consistency in dates. The species was also found at Topchanchi and Hazaribagh in Jan. and Feb. 1970.

Dicrurus aeneus Vieillot,

BRONZED DRONGO

Small glossy blue drongos with less strongly forked tails were recorded on 4 occasions deep in the sal jungle on 18.vi.68 (2), 24.viii.68, 13.ii.69 and 2.iv.69. It is possible to birds may have occupied a territory because they were always in the same place. A feature of these birds was a long-headed appearance due to a tuft of plush-like feathers on the forehead hiding the base of the bill and longish feathers on the nape, rather like *D. remifer* Lesser Racket-tailed Drongo.

Dicrurus hottentottus (Linnaeus),

HAIRCRESTED DRONGO

A scarce but annual visitor to my garden in spring with 4 records on 5.iv.68, 24.iii.69, 19.ii.70 and 6.iii.71. Another was seen near Panagarh on an unrecorded date.

Dicrurus paradiseus (Linnaeus),

GREATER RACKET-TAILED DRONGO

One in the sal jungle on 21.iv.68. Rather a scruffy specimen without rackets.

Artamus fuscus Vieillot,

ASHY SWALLOW-SHRIKE

A common resident throughout the area seen circling in the sky or bunched together on wires or bare tree branches. The birds were rather less in evidence over my garden during April and May but numerous in June, July and August. This suggests the birds may have retired to breed during the hot weather so that free flying young could reap the harvest of flying insects during the monsoon.

Sturnus malabaricus (Gmelin),

GREYHEADED MYNA

Quite a common resident with small flocks scattered about the countryside, flowering Silk Cotton trees and lantana bushes being favoured haunts. Birds recorded in my garden between March and July.

Sturnus pagodarum (Gmelin),

BRAHMINY MYNA

Recorded only from Topchanchi. Lowther listed it for Manbhum.

Sturnus contra Linnaeus,

PIED MYNA

A very common resident favouring the wetter parts of the area. A well watered lawn proved attractive during the hot weather. It would usually outnumber the Common Myna on Calcutta train counts.

Acridotheres tristis (Linnaeus),

COMMON MYNA

An abundant resident throughout the area, but outnumbered by Pied Myna in wet paddy. Fledged young appeared on my lawn in June 1969 and August 1970.

Acridotheres ginginianus (Latham),

BANK MYNA

Birds could be seen regularly at Howrah station in December 1970 and January 1971. Apart from these the only record was of two pairs beside the GT road on the Durgapur side of Burdwan on 26.v.68.

Dendrocitta vagabunda (Latham),

INDIAN TREE PIE

A common resident throughout the area, particularly my garden and the sal jungle.

Corvus splendens Vieillot,

HOUSE CROW

An excessively abundant resident throughout the area. The maximum count from the Calcutta train was 91.

Corvus macrorhynchos Wagler,

JUNGLE CROW

Thinly distributed resident and much less numerous than previous species. Maximum count from the Calcutta train was 23 but usually only 6 to 8. A bird in Dalhousie Square on 11.xii.70 suggests it is quite capable of penetrating urban areas. Birds were visiting my garden quite regularly from March 1970 onwards.

Tephrodornis pondicerianus (Gmelin),

COMMON WOOD SHRIKE

Probably resident but rather scarce with 10 records scattered through the year. All were singles except for 2 together in my garden on 21.xi.70.

Coracina novaehollandiae (Gmelin),

LARGE CUCKOO-SHRIKE

5 records from in and around my garden in April and June 1968 and 8 between March and July 1969 (3 together on one occasion)

suggested the species was a hot weather and monsoon visitor. However in 1970 the only records were in August and December, apart from January and February records from Topchanchi and Hazaribagh. The species is probably a mobile resident.

Coracina melanoptera (Ruppell),
BLACKHEADED CUCKOO-SHRIKE

In 1968 and 1969 it appeared to be a monsoon visitor from April to August, once October. However in 1970 it first appeared on 29th March and was seen regularly upto 21st November and two more records in January 1971 suggested it was resident. Nearly all the records were for my garden, the few outside being in the nearby sal jungle. Never more than a pair together.

Pericrocotus flammeus (Forster),
SCARLET MINIVET

Only found at Topchanchi on 25.i.70.

Aegithina tiphia (Linnaeus),
COMMON IORA

A common resident of my garden and adjacent jungle, usually in pairs. Seen in every month of the year but less frequently in December.

Chloropsis cochinchinensis (Gmelin),
GOLDMANTLED CHLOROPSIS

Birds in my garden in every month of the year, usually a pair but 4 on 2.xi.70. This nectar feeding species has presumably benefited from the widespread planting of exotics such as poinsettia, hibiscus etc. in gardens. It was never found in sal jungle but would be hard to find in the canopy. It was found at Topchanchi on 25.i.70 which is more open and varied.

Pycnonotus jocosus (Linnaeus),
REDWHISKERED BULBUL

A very common resident of my garden and jungle with small parties throughout the year. It showed a stronger preference for better wooded areas than the even commoner Red-vented Bulbul. One or more pairs nested in my garden every year, activity first recorded on 17th April with nearly fledged young in June and July.

Pycnonotus cafer (Linnaeus),
REDVENTED BULBUL

One of the most abundant birds of West Bengal, occurring widely in gardens, sal jungle and scrub. Upto 7 or 8 birds in my garden throughout the year where it nested regularly. Activity first recorded on 20th April with fledged young in July. With so little attempt to hide the flimsy nest structures the loss through predation and storm damage must have been very high.

Pycnonotus luteolus (Lesson),
WHITEBROWED BULBUL

3 together in some scrub in the Forest Dept plantations towards the Ajoy river on 18.i.70. This is about 100 km NE of the Midnapore limit given in the HANDBOOK.

Dumetia hyperythra (Franklin),
RUFOUSBELLIED BABBLER

A regular monsoon visitor to my garden between May and August, usually 2 or 3 but upto 6 in 1970.

Chrysomma sinense (Gmelin),
YELLOWEYED BABBLER

A common resident usually found in pairs but 4 together on one occasion. Frequent visitor to my garden in every month of the year. Water-side scrub at AW was another favoured haunt.

Turdoides striatus (Dumont),
JUNGLE BABBLER

A very common bird of gardens and sal jungle, being seen in my garden almost daily. It nested during the monsoon with fledged young appearing in August and September. It was also found at Topchanchi.

Muscicapa latirostris Raffles,
BROWN FLYCATCHER

Only two records, both in April in different years. One on the edge of the sal jungle near my bungalow and one in scrub near the triangulation point.

Muscicapa muttui (Layard),
BROWNBREASTED FLYCATCHER

Two records, one in sal jungle near my bungalow and the other at AW, on 20.ix.70 and 26.ix.70 respectively. These records fit the expected migration pattern of birds moving between their breeding areas in Assam and beyond and the wintering area in SW India.

Muscicapa ruficauda Swainson,
RUFOUSTAILED FLYCATCHER

One in my garden on 26.iii.69 in company with the Blackbrowed Flycatcher Warbler (*Seicercus burkii*). Additional literature which was not available to me at the time indicates the possibility of other flycatchers with reddish tails but has not changed my opinion.

Muscicapa parva Bechstein,
REDBREASTED FLYCATCHER

One of the commonest and most conspicuous of winter visitors to gardens and the fringes of sal jungle. Low branches of trees bordering the colony roads and providing a clear view of open ground were particularly favoured. The earliest arrival was on 14th Oct. and the latest on 6th April, a bird with a red breast. The only other record of a redbreasted bird was on 23.i.70.

Muscicapa superciliaris Jerdon,
WHITEBROWED BLUE FLYCATCHER

One at AW on 30.iii.69, also 1 at Hazaribagh NP on 9.ii.70 which suggests the status of scarce spring migrant.

Muscicapa rubeculoides (Vigors),
BLUETHROATED FLYCATCHER

One beside the road outside my garden in the first week of March 1968.

Muscicapa tickelliae (Blyth),
TICKELL'S BLUE FLYCATCHER

One in the next door garden on 24.iii.68 and probable females in my garden on 28.x.68 and 20.xii.69.

Muscicapa thalassina Swainson,
VERDITER FLYCATCHER

Regular winter visitor in small numbers with at least one record each year from my garden or the sal jungle. Two together in my garden on 10.iii.71. Also seen at Topchanchi on 25.i.70 and Maithon Dam on 24.i.70.

Culicicapa ceylonensis (Swainson),
GREYHEADED FLYCATCHER

An irregular winter visitor in sal jungle with 7 records between 14.xi.68 and 23.ii.69. Also at Topchanchi on 26.i.70.

Rhipidura aureola Lesson,
WHITEBROWED FANTAIL FLYCATCHER

Not recorded nearer than Topchanchi where it was seen on 25.i.70. It was also found at Hazaribagh NP on 9.ii.70. The species appears to prefer a more definitely deciduous biotope than Durgapur could offer.

Rhipidura albicollis (Vieillot),
WHITETHROATED FANTAIL FLYCATCHER

A single individual took up residence in and around my garden from 1.vii.69 to 23.viii.69 during which time it was seen almost daily.

Terpsiphone paradisi (Linnaeus),
PARADISE FLYCATCHER

A common and conspicuous monsoon visitor of almost daily occurrence in gardens and sal jungle between extreme dates of 28th March and 30th September. Females tended to arrive a few days before males. The first males of the year were recorded on 3.iv.68, 3.iv.69 and 4.iv.70.

Hypothymis azurea (Boddaert),
BLACKNAPED FLYCATCHER

A regular winter visitor to the sal jungle from November to February. Usually singly or in pairs with mixed groups of warblers and flycatchers.

Cisticola juncidis (Rafinesque),
STREAKED FANTAIL WARBLER

Rather scarce and local but probably resident in suitable areas of long grass or dense low shrubs which were free of grazing pressure. Tussocks of 'pampas' grass (*Cortaderia* sp ?) on the sand banks downstream of AW and also the downstream face of Maithon Dam.

Prinia hodgsonii Blyth,
FRANKLIN'S LONGTAIL WARBLER or WREN WARBLER

Much scarcer than *P. socialis* and recorded only between April and September in 1968 and 1969. Due to closer similarity with *P. socialis* when in winter plumage it may have been overlooked at other times.

Prinia subflava (Gmelin),
PLAIN, or TAWNYFLANKED LONGTAIL, or WREN WARBLER

Nearly all records from waterside vegetation at DB where it was present throughout the year except Sept.-Oct. and only a single Nov. record. Birds were nesting in water hyacinth on 21.vi.68. It was also found in canal-side vegetation on the way to AW and at Canada Dam on 23.iii.69.

Prinia socialis Sykes,
ASHY LONGTAIL WARBLER or WREN WARBLER

A very common resident in and around gardens occurring in small parties.

Orthotomus sutorius (Pennant),
TAILOR BIRD

A common garden resident, also found in sal jungle and suitable scrubby cover. A protracted monsoon breeding season with feeding of young noted between April and September.

Locustella certhiola (Pallas),
PALLAS'S GRASSHOPPER WARBLER

One at AW in March 1968. Another *Locustella* of uncertain species at the same place on 27.iv.69.

Chaetornis striatus (Jerdon),
BRISTLED GRASS WARBLER

My experience with this species is an example of how a mistake once made can be difficult to rectify. Shortly after my arrival in India I found some birds resembling Jungle Babblers but with streaked upper parts in an area of long grass between Panagarh and the Damodar canal. With my limited experience at that time I put these down as Common Babblers, *T. caudatus.* Similar birds were subsequently seen on four occasions in long grass or scrub at AW and 1 downstream of DB on 5.xii.70 and 2 birds were seen in a trackside ditch from a train to Calcutta. It was not until after I left India did I learn of the similarity and possibility of confusion between this species and Common Babbler, a bird which reaches its eastern limit in Bihar.

The fact that I always saw these birds in ones or twos and not the small parties so typical of *Turdoides* spp. should have given a warning that something was not right. With the benefit of hindsight it is now evident the original diagnosis was wrong, hence the entry under this species.

Acrocephalus aedon (Pallas),
THICKBILLED WARBLER

One bird watched closely at DB on 17.ii.68. Detailed notes refer to the lack of supercilium, massive bill and short wings.

Acrocephalus stentoreus (Hemprich & Ehrenberg),
INDIAN, OF CLAMOROUS GREAT REED WARBLER

A winter visitor to waterside vegetation at AW and DB from 15th Nov. to 11th April.

Acrocephalus dumetorum Blyth,
BLYTH'S REED WARBLER

A common spring migrant through my garden and sal jungle in March, April and May with 2 February records and 1 at AW in January, the latest date was 23rd May.

Acrocephalus agricola (Jerdon),
PADDYFIELD WARBLER

2 records at DB, one in February 1968 and one on 11.iv.70.

Hippolais caligata (Lichtenstein),
BOOTED WARBLER

Mainly a late winter visitor or spring migrant between February and May but 1 at AW on 26.ix.70. 4 records in my garden during April/May 1970 may have been the same individual.

Phylloscopus collybita (Vieillot),
CHIFFCHAFF

Winter resident in small numbers to my garden and sal jungle. Another regular haunt was the avenue of large trees leading down to AW. Recorded between 23rd November and 20th April.

Phylloscopus affinis (Tickell),
TICKELL'S LEAF WARBLER

Winter visitor in small and irregular numbers. Several records in sal jungle in February/April 1968 and in my garden in February/March 1971. Only 2 1970 records.

Phylloscopus griseolus Blyth,
OLIVACEOUS LEAF WARBLER OF SULPHURBELLIED WARBLER

The species was quite common at Topchanchi on 25.i.70, and also in Hazaribagh NP the following month. A bird seen in the sal jungle at Durgapur on 3.iv.68 with other phylloscopi was thought at the time to be a Radde's Warbler *P. schwarzi*, a species not officially recorded within Indian limits. Having had the opportunity of seeing both species on their respective breeding grounds in the Tien Shan mountains and Siberia I now think it probable the bird was *P. griseolus*. Another rather uncertain record on 25.ii.69.

Phylloscopus fuscatus (Blyth),
DUSKY LEAF WARBLER

Three records in Dec. and Jan. of several birds in low thorny scrub at AW and DB.

Phylloscopus inornatus (Blyth),
YELLOWBROWED LEAF WARBLER

Common winter visitor, the second commonest *Phylloscopus* after Greenish Warbler. Distinctly gregarious, usually in groups of 5-15 in sal jungle but once in my garden. The earliest arrival was 14th Nov. and the latest was 16th April, but 1968 was the only year when it was recorded after February.

Phylloscopus magnirostris Blyth,

LARGEBILLED LEAF WARBLER

Single birds in February 1968 and 1969 identified by larger size, heavier bill and stronger colouring compared with associated Greenish Warblers. Could only be identified under optimum conditions and may have been under recorded. A detailed study, using mist nets, of the phylloscopi in West Bengal in winter would be rewarding.

Phylloscopus trochiloides (Sundevall),

GREENISH WARBLER, or DULL GREEN LEAF WARBLER

The commonest *Phylloscopus* to visit West Bengal in winter. Frequently seen in my garden, sal jungle or any sort of trees with a reasonable canopy. The earliest date was 15th Sept. and the latest 17th May. Much more likely than other members of its genus to be found singly but not averse to joining mixed flocks.

Phylloscopus nitidus Blyth,

BRIGHT GREEN LEAF WARBLER

A single bird in my garden on 4.v.68.

Phylloscopus occipitalis (Blyth),

LARGE CROWNED LEAF WARBLER

Either a late winter visitor or spring migrant. After 2 or 3 earlier records, birds were seen on 31.iii.68, 3.iv.68, 4.iv.68, 11.ii.69 and 23.ii.69 in sal jungle, also at Topchanchi on 26.i.70.

Phylloscopus reguloides (Blyth),

BLYTH'S CROWNED LEAF WARBLER

A single bird in my garden on 10.v.68 was watched at close range for some time and detailed notes taken enabled it to be identified as this species rather than the previous one. This record is rather late and further south than might be expected from the information in the HANDBOOK.

Seicercus burkii (Burton),

YELLOW-EYED FLYCATCHER-WARBLER

One in my garden on 26.iii.69, in association with the Rufoustailed Flycatcher.

Erithacus svecicus (Linnaeus),

BLUETHROAT

Regular winter visitor to waterside scrub at DB and AW. Earliest 28th Dec. latest 28th March.

Copsychus saularis (Linnaeus),

MAGPIE ROBIN

Common resident in gardens, seldom seen in sal jungle. An opportunist nester taking over old nest of Indian Robin and Crimson-breasted Barbet. The nesting season was prolonged with song and display seen in February, eggs in July (1969) and fledged young in August (1969 and 1970).

Phoenicurus ochruros (Gmelin),

BLACK REDSTART

Winter visitor to roadsides, jungle fringes and open areas, earliest 22nd November, latest 17th April. Only one in my garden but often seen close to it.

Saxicola torquata (Linnaeus),

STONE CHAT

Winter visitor, probably regular to riverside vegetation and sandy scrub at AW and DB between 6th Oct. and 7th April. Usually a pair but 2 pairs at AW on 6.x.68.

Saxicoloides fulicata (Linnaeus),

INDIAN ROBIN

A very common bird of gardens, sal jungle and scrub. Seen almost every day in my garden. Display noted in February and nesting from May to July.

Monticola cinclorhynchus (Vigors),
BLUEHEADED ROCK THRUSH

One bird, a male, in the jungle close to my bungalow on 31.iii.68.

Monticola solitarius (Linnaeus),
BLUE ROCK THRUSH

A single bird wintering at AW favouring an overgrow pile of old facing stones. Also at Canada Dam on 23.iii.69.

Zoothera citrina (Latham),
ORANGEHEADED GROUND THRUSH

A regular winter visitor to my garden and sal jungle, normally only one bird but two on one occasion. Earliest date was 26th October and the latest 15th April. All the birds I saw were *Z. c. citrina*. It is listed by Lowther as a breeding bird in Manbhum district but presumably *Z. c. cyanotus*.

Zoothera dauma (Latham),
WHITE'S THRUSH

Two birds together in the local sal jungle on 12.xii.68.

Turdus unicolor Tickell,
TICKELL'S THRUSH

A scarce winter visitor to my garden and sal jungle between 15th November and 14th March. The only record in 1968 was at Topchanchi on 14.iii.68.

Anthus hodgsoni Richmond,
INDIAN TREE PIPIT, or OLIVEBACKED PIPIT

Common winter visitor to my garden and adjacent jungle in small flocks upto 6, earliest date was 24th October and the latest 14th April.

Anthus trivialis (Linnaeus),
TREE PIPIT

Erratic winter visitor recorded at DB and AW on several occasions between 14.xii.68 and 18.i.69. No records for subsequent years.

Anthus novaeseelandiae Gmelin,
PADDYFIELD PIPIT, or RICHARD'S PIPIT

A. n. rufulus resident in small numbers in suitable open areas such as bund roads, sand banks with some vegetation, playing fields etc. Nesting behaviour noted in April. 2 records of *A. n. richardi* at DB in March.

Anthus campestris (Linnaeus),
TAWNY PIPIT

5 winter records from AW and DB between September and Feb.

Anthus roseatus (Blyth),
HODGSON'S PIPIT, or VINACEOUSBREASTED PIPIT

One at DB on 14.iv.68 is the only record.

Anthus similis Jerdon,
BROWN ROCK PIPIT, or LONGBILLED PIPIT

I obtained photographs of a large almost unmarked pipit on the shore of Panchet reservoir in February 1968 and another in fallow land near AW on 16.ii.69 which could be directly compared with photographs of Tawny Pipits taken in France and Greece. These birds lacked the dark row of covert spots so noticeable on Tawny Pipits.

Motacilla indica Gmelin,
FOREST WAGTAIL

A passage migrant in March/April and September with records in my garden on 28.iv.68, 18.iii.69, 1.ix.70 and 6.ix.70 and 1 in nearby jungle on 17.ix.68.

Motacilla flava Linnaeus,
YELLOW WAGTAIL

Numerous winter visitor to AW and DB

from November to April. Birds were also seen on playing fields at Dishegarh on 29.xii.69. Those which could be assigned to a particular race appeared to be *M. f. beema.*

Motacilla citreola Pallas,

YELLOWHEADED WAGTAIL, or CITRINE WAGTAIL

Winter visitor to DB and AW in fluctuating numbers. It was recorded commonly in the early months of 1968 and again from December 1968 to April 1969. The following winter it was recorded only during Jan. and Feb. 1970. There were no records at all for the 1970/71 winter.

Motacilla cinerea Tunstall,

GREY WAGTAIL

1 at DB on 13.ii.70 and 1 on the village tank near the hot spring shrine north of Dubrajpur on 23 or 24.i.68.

Motacilla alba Linnaeus,

PIED WAGTAIL

Common and widespread winter visitor to a variety of habitats, including my office window-sill. It is impossible to know if a bird at AW on 27.vii.69 really was a very early winter visitor or an individual which had summered. Apart from this unusual date the species was recorded from 26th September to 11th April.

Motacilla maderaspatensis Gmelin,

LARGE PIED WAGTAIL

Apparently resident at DB with 3 birds on two occasions in March and September 1970. Recorded 3 times at AW from 11.viii.68 to 5.i.69 and on the only visit to Canada dam on 23.iii.69.

Dicaeum agile (Tickell),

THICKBILLED FLOWERPECKER

One or two records in my garden each summer between 15th April and 17th Sept.

Dicaeum erythrorhynchos (Latham),

TICKELL'S FLOWERPECKER

A regular monsoon visitor to my garden from mid-May to mid-September with a single bird of almost daily occurrence. 2 birds were seen together on 25.vii.69. It was seen regularly from mid-April in 1970. The fruits of the Malayan 'cherry' *Muntingia calabura* proved irresistable to it.

Nectarinia zeylonica (Linnaeus),

PURPLERUMPED SUNBIRD

1 outside Woodlands Nursing home in Calcutta on 14.vii.70 is the only record. From the map in the HANDBOOK Durgapur would only be on the extreme border line of the bird's distribution.

Nectarinia asiatica (Latham),

PURPLE SUNBIRD

A common resident which must have benefited greatly from the planting of decorative trees and shrubs in gardens. The birds appeared to breed in the dry season which coincided with the peak flowering of the local flora. Display was noted in my garden in January with the first signs of eclipse plumage showing at the end of June. By August all males were in complete eclipse with full breeding plumage being regained in December.

Zosterops palpebrosa (Temminck),

WHITE-EYE

Quite common in the undergrowth at Topchanchi but only a scarce winter visitor to the Durgapur area. Records of 2 or more birds in the sal jungle on 16.ii.69 and in my garden on 3.i.70 and exactly a year later on 3.i.71.

Passer domesticus (Linnaeus),

HOUSE SPARROW

Excessively abundant resident around all houses and habitation. No clearly defined breeding season, being almost year-round.

Petronia xanthocollis (Burton),
YELLOWTHROATED SPARROW

7 records between March and July of 1 or 2 birds in my garden or sal jungle. Seen 4 times in 1968, twice in 1969 and once in 1970.

Ploceus philippinus (Linnaeus),
BAYA WEAVER

An abundant resident, their colony nests suspended from palmyra palms and other trees being a common sight. Nest building usually began in May and continued through the monsoon.

Ploceus benghalensis (Linnaeus),
BLACKTHROATED WEAVER

Not always distinguished from and sometimes mixed with Baya Weavers. Flocks could be found fairly regularly in waterside vegetation at DB and along the canal on the way to AW.

Estrilda amandava (Linnaeus),
RED MUNIA

A resident flock of 20-30 at DB were the only ones seen in the area.

Lonchura malabarica (Linnaeus),
WHITETHROATED MUNIA

Common resident with flocks of upto 25 with Spotted Munias on seeding grasses and flowers during the monsoon. Seen much less frequently from December to March.

Lonchura punctulata (Linnaeus),
SPOTTED MUNIA

A very common resident with flocks of upto 100 on lawns in May and June. Nest building was very protracted from June to November but few nests reached a more productive stage. Many complete but empty nests were taken over by Whitethroated Munias.

Lonchura malacca (Linnaeus),
BLACKHEADED MUNIA

1 appeared at DB on 1.viii.70 and was seen subsequently on 13.ix.70 and 15.xi.70 This was a white bellied bird of the race *L. m. malacca* and thus may have been an escaped cage bird because Durgapur is within the range of the chestnut bellied race *L. m. atricapilla*. However the dates would fit post breeding dispersal.

Carpodacus erythrinus (Pallas),
COMMON ROSEFINCH

A scarce spring migrant with 2 records in or near my garden on 4.iii.68 and 5.v.68. Also at Topchanchi on 25.i.70.

Melophus lathami (Gray),
CRESTED BUNTING

A single record of a male of this unmistakable species among scrub in a small sandy river bed beside the Panagarh — Ilam Bazar road on 24.i.68. This locality would appear to be outside the expected range given in the HANDBOOK but the date is suitable for winter movements. The particularly dry weather at the time could have caused a wider dispersal than usual.

Discussion

The systematic list covers 294 species found in an area about 320 km long from Topchanchi to Calcutta by about 150 km from Messenjore (Canada Dam) to Bankura. Of these species, 11 were found only at Topchanchi but more diligent searching might find some of them on the forest clad hills such as Panchet and those round Maithon. The latter place was the only locality for 2 species, Painted Spurfowl and Rufoustailed Finch Lark. 4 species. Herring Gull, Blackheaded

Gull, Larger Goldenbacked Woodpecker and Purplerumped Sunbird were found only in or near Calcutta but the two gulls could well turn up in Durgapur as they do occasionally at Delhi which is a lot of further from the sea. A further 5 species, Greater Adjutant, Black Ibis, Black Eagle, Rain Quail, and Bank Myna were single records more than 50 km from Durgapur. This leaves a total of 272 species within an arbitary 50 km from Durgapur in 3 years and 3 months by a single part time observer.

Hutson (1954) recorded *c.* 250 species within 16 km of Delhi in 2½ years and the checklist of the Delhi Birdwatching Club gives 333 species (excluding accidentals). That is the total effort by numerous observers over a large number of years. Doubtless the Durgapur list could be expanded by a similar effort.

Holmes and Wright (1968) working in Sind for 3 years listed 267 species recorded by themselves, again on a part time basis but with more opportunity for observation.

Ghorpade (1973) in his survey of Sandur district in Karnataka listed 167 species and suggested the ultimate total might be about 250. However his area was largely devoid of aquatic habitat.

The number of species recorded in or from my garden was 126 which compares with the 135 species recorded by MacDonald (1960) in the larger more mature garden of the British High Commission in Delhi also over a 3 year period.

If records for the adjacent colony, sal jungle and my regular daily route to and from my office are included, the total rises to 162. This will be referred to as the colony area. The observations made in the colony area can be compared with the work of Gaston (1978) on the New Delhi ridge who studied a restricted area there regularly over 3 years.

In a study of this nature the seasonal status of a species must be of a somewhat subjective nature. My category of 'resident' does not necessarily imply breeding, only that it was seen regularly throughout the year.

Table 1 gives the seasonal categories of the 162 species in the colony area and 272 for Durgapur as a whole and compares them with the 167 species recorded by Gaston on the New Delhi ridge (ND ridge) and the 333 of the Birds of Delhi and District : Field Check List (ND list). Gaston's data is slightly different because he considered only 322 species from the check list.

TABLE 1

	Colony area		Durgapur		ND Ridge		ND List	
	No.	%	No.	%	No.	%	No.	%
Resident or Regular	62	38	93	34	47	28	186	56
Winter visitor	36	22	90	33	27	16	107	32
Summer visitor	33	20	28	11	23	14	15	5
Migrant	22	14	44	16	38	23	21	6
Occasional or non-seasonal	9	6	17	6	32	19	4	1
Total	162	100	272	100	167	100	333	100

The apparent anomaly of the colony area having more summer visitors than the whole of Durgapur of which it is a part, is explained by a number of species, particularly water birds which are resident in other parts such as DB, spread out widely during the monsoon and turn up in the colony area at that time. Also, certain species occur only on passage in the colony area in autumn but winter elsewhere in Durgapur. Gaston noted a similar situation when comparing his study area with rest of Delhi.

Care must be exercised when comparing the figures in such a table due to different observational techniques and different interpretations of the various categories by the authors. Gaston's low figure for residents and high figure for occasionals may be due to a more rigorous definition of resident but the comparative lack of habitat variety in his study area is a factor. However he recorded 32 species in every week of his study with 30 species in every week in my colony area. (see appendix 3). Of the species which occurred in every week, only 13 are common to both areas.

It is evident that the whole of Delhi has much the highest number and proportion of residents and this reflects the more complete coverage over the years. The low figure for occasionals in the Delhi list is misleading because the table excludes 60 species listed as accidental (less than 5 records in 40 years). If these are included, the figure becomes 64 occasionals out of a total of 393 or 19%, the same percentage as Gaston's figure for the ridge. 10 of the Delhi accidentals are quite common or regular in Durgapur. These are Crested Hawk Eagle, Bronze-winged Jacana, Lesser Golden Plover, Blackheaded Oriole, Ashy Swallow-Shrike, Greyheaded Myna, Large Cuckoo-Shrike, Rufousbellied Babbler, Forest Wagtail and Thickbilled Flowerpecker.

The proportion of winter visitors is very similar in Durgapur and Delhi but the composition is a bit different. Due to its geographical location Delhi is reached by a number of species from SE Europe and SW Asia which do not extend across to Durgapur. The Brown Shrike is the only eastern species which extends its winter range westwards into the Durgapur area. The mountain ranges of Tibet and the Himalayas are a formidable barrier to eastern palaearctic birds and they are steered to the south east away from India.

Durgapur has many more summer visitors than Delhi. The colony area has almost half as many again as the ND ridge and the whole Durgapur area has almost twice as many as the ND list. The longer and wetter rainy season in West Bengal is clearly a factor. Some of the smaller herons listed as summer visitors in Durgapur may actually be resident but they are only seen when active during the monsoon.

The low figure for migrants in the ND list is a bit surprising compared with Gaston's figure but he does say that birds passing through his area do winter elsewhere in Delhi. Durgapur has more migrant species but the most striking difference is the relative proportions between spring and autumn.

Gaston identifies 38 species as passage migrants, 8 being mainly in autumn, 4 mainly in spring and the remaining 26 being equally divided. The 22 migrant species in the colony area are divided into 4 species in autumn only, 17 spring only and 1 in both seasons. The 44 migrants in Durgapur are divided into 7 in autumn only, 35 in spring only and 2 (Grey Plover and Forest Wagtail) in both.

The likely explanation for this difference in migration pattern is that birds arriving in the Delhi region from the north and north-west in autumn encounter congenial feeding grounds nourished by the recent monsoon and these are exploited until increasing dessication forces the birds to disperse to the more humid south and east. Thus birds appearing in Durgapur in spring are completing the last part of their winter stay in the sub-continent in Bengal. The Yellowbrowed Warbler becomes more numerous in late winter and early spring suggesting immigration from elsewhere. It has already been noted that the sal jungle around Durgapur still carries a good leaf cover during February-April whereas the forest 130 km to the west is almost bare. A single January visit

to the Hazaribagh NP some 200 km to the west found the absence of foliage was more pronounced. Almost half the spring migrants in Durgapur are canopy feeding insectivorous warblers and flycatchers which exploit this to advantage. A second explanation is that some species which migrate southwards through Delhi in autumn continue down the west side of the peninsular and return up the eastern side in spring for the reason given above. Blyth's Reed Warbler is a case in point.

This preponderance of spring migrants gives a different complexion to the avifauna of Durgapur compared with Delhi when the number of species occurring in each month is considered. See table 2 below.

TABLE 2

	J	F	M	A	M	J	J	A	S	O	N	D
Durgapur	164	174	168	154	122	110	102	114	124	97	121	135
ND ridge	68	90	118	109	71	60	80	84	111	103	92	89

The Durgapur figures show a single late winter peak falling to a minimum in July. The low figure for October is almost certainly due to the poor coverage in that month, I was absent for part or the whole of that month in each year. (See appendix 2). In contrast the ND ridge figures show peaks in March and September, the main migration months, and minima in June and January. There may be some observer bias tending to exaggerate the difference between best and worst periods in that better rewards may spur greater effort. Also birdwatching during monsoon thunderstorms is neither very pleasant nor productive.

The results of the work embodied in this paper show that the ornithologically neglected West Bengal plains have a diversity of avifauna comparable with other parts of lowland India. Thus the naturalist who finds himself in an area of heavy industrial development located in a monotonous plain under a monoculture of rice need not despair. The results can be surprising.

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My thanks to Ananta Mitra and Ann Talbot Smith who responded to my request for help in identifying *Muntingia calabura* through the pages of the Newsletter for Birdwatchers and its editor, Zafar Futehally for passing the information on to me.

APPENDIX 1

FREQUENCY OF VISITS TO DB AND AW. VISITS PER MONTH IN EACH YEAR

DB	J	F	M	A	M	J	J	A	S	O	N	D
1968	–	2	3	3	2	2	1	4	3	1	2	2
1969	1	5	3	3	1	1	1	–	–	–	2	2
1970	3	3	2	2	2	–	1	1	3	1	3	3
1971	2	2	1									
AW												
1968	3	1	–	1	1	–	–	2	–	1	–	1
1969	1	2	–	1	–	–	1	1	–	–	1	–
1970	1	1	–	–	–	–	–	1	1	1	–	–
1971	1	–	–									

APPENDIX 2

MY ABSENCES OF A WEEK OR MORE FROM DURGAPUR

1968	13/x – 22/x,
1969	1/iii – 7/iii, 7/iv – 16/iv, 30/iv – 11/v, 25/viii – 14/xi
1970	7/iii – 21/iii, 4/x – 13/x,
1971	Departed 18.iii.71.

APPENDIX 3

LIST OF BIRDS RECORDED IN EVERY WEEK

Pond Heron
Cattle Egret
Little Egret
* Black Kite
* Whitebacked Vulture
Spotted Dove
* Roseringed Parakeet
Koel
Palm Swift
Indian Roller
Little Green Bee-eater
Black Drongo
Ashy Swallow-Shrike
Pied Myna
* Common Myna
* Tree Pie
* House Crow
Common Iora
Goldmantled Chloropsis
* Redwhiskered Bulbul
* Redvented Bulbul
* Jungle Babbler
* Ashy Wren-Warbler
* Tailorbird
Magpie Robin
* Indian Robin
* Purple Sunbird
House Sparrow
Baya Weaver
Spotted Munia

An * indicates those species which also appear on Gaston's list of birds recorded in every week.

A further 4 species, Collared Dove, Little Brown Dove, Yellow-eyed Babbler and Blackheaded Oriole failed to make the above list by only a narrow margin.

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ZANGI NAWAR — PORTRAIT OF A UNIQUE LAKE IN THE DESERT[1]

T. J. ROBERTS[2]

Though the Province of Baluchistan lies on the extreme western boundary of the Indian sub-continent, its fauna and flora have been reasonably well documented both in regional surveys and in publications covering the entire country of Pakistan or the sub-continent (See R. I. Pocock and Stuart Baker, FAUNA OF BRITISH INDIA Series (1900-1929) and Salim Ali's HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN 1968-1974). It is a large and extensive province, covering an area of 131,855 square miles (341,500 square kilometres) and extending from latitude 24° North on the Mekran coast up to 32° North on the borders of south Waziristan. Most of the southern portion of the province is arid semi-desert, and the northern regions with more extensive mountain systems and plateaus, still remain semi-arid steppe or steppic montane. There are only five lakes in the entire Province, of which 3 are wholly man-made and two of these being reservoirs near Quetta are devoid of cover and of little ornithological interest. The largest of these, Habb Dam reservoir straddles the Sind border near Karachi and in the five years since it was flooded, has already become an important wildlife refuge. The Province lies in a strategic area for Palearctic bird migrants, especially those wintering in east and southern Africa but which breed in central Asia. Also it forms a staging area for migrant birds which winter in the Indian sub-continent but breed in the Black and Caspian sea regions as well as eastern Europe. To the north and west of Baluchistan lie the inhospitable deserts of the Seistan basin and to the southeast the vast deserts of Thar and Rajasthan. It is no wonder therefore that the very few wetland areas in this region afford vital resting and staging areas not only for migrant waterfowl but for a host of passerine species.

The first and only published accounts of the ornithology of Zangi Nawar were made during World War II (Christison 1941) but it is evident from his writing that he was not able to explore the lake during the spring or summer breeding season and compared with Kushdil Khan Lake located 40 miles (64 kilometres) from Quetta, its ornithology is still relatively unexplored. Because of its relative remoteness and inaccessibility, the author did not make an prolonged visit to the lake until January 1984, following reliable reports of sightings during part of January and February the previous year of seven Whooper Swans (*Cygnus cygnus*) (Ashiq Ahmad, *JBNHS* Vol. 82, 1985). My winter visit was followed up by a second during the first week of May in order to assess the potential breeding population of birds.

PHYSICAL FEATURES

Zangi Nawar lies at 29°27′N latitude and 65°47′E longitude in the district of Chaghai in extreme southwest part of the province.

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Situated at an elevation of about 3200 feet (975 metres), it extends in a chain of lagoons over a distance of about 8 miles (12.8 kilometres) in an east-west axis, bounded on both sides by high sand-dunes and fed naturally from a stream (locally known as the Bohr Lora), which drains from the hills to the north east. According to seasonal rainfall conditions it varies considerably in both surface area and depth. After good rains it covers an area of approximately 2070 hectares with an average depth of 3.5 feet (1.067 metres) deepening to 6 or 7 feet (2.13 metres) in the northern boundary where the inlet stream flows down from the hills. In the summer months it usually shrinks considerably both in depth and area though it never dries out and the southern portion covering an area of approximately 770 hectares with an average depth of 3 feet (0.9 metres) still provides an extensive refuge for wildlife. The lake is quite saline, having a pH value of 9.2 with 7.27 grams per litre of total dissolved solids, comprising mostly bicarbonates (See water analysis Appendix I). The bottom of the lake is carpetted with green moss algae, through which grows a mat of the aquatic weed *Ruppia maritima*, with here and there smaller patches of *Potamogeton pectinatus*. These aquatic plants provide the major sustenance in winter time for huge concentrations of Coot (*Fulica atra*). Despite its high salinity, fish up to 8 cms. in length occur along the north-western fringes of the lake nearest to the inlet stream. Efforts to secure specimens for identification with a hand net were unsuccessful.

The lake itself is completely hidden by high wing-blown sand dunes on all sides and lies in a truly desolate uninhabited area which alternates with stony peneplain or low ridges of bare sedimentary rocks. It is all the more astonishing therefore, after grinding over shifting sands in 4-wheel drive, to suddenly come upon its tamarisk fringed shores, and numerous lagoons and islets covered with luxurious stands of *Typha angustifolia* (Reed Mace or Cattail) and *Phragmites karka* reeds. Unlike several species of Tamarisk which grow in the plains, this particular tamarisk (*Tamarix articulata*) is deciduous, its leaves turning a rich tawny orange enhancing the beauty of the lake and indicating a valuable adaptation to the harsh cold winters prevalent in the Chaghai. The dominent emergent vegetation in the lake is *Phragmites karka*, which occurs in dense but isolated clumps of reed beds all over the lake surface. On the surrounding sandhills there are thinly scattered bushy clumps of the xerophytic grass *Eluseusine flagilifera*, as well as woody stunted bushes of *Calligonum polygonoides*.

The climate is arid and dry throughout the year with an average annual precipitation of 76 mm. at Nushki, the headquarters of Chaghai district, which is located 30 miles (48 kilometres) distant from Zangi Nawar. There is no monsoon influence nor any season of reliable rainfall but usually some winter and spring showers occur. Mean temperatures prevailing during June and July the hottest months, are around 39.6°C. (103.3°F.) reaching a maximum of 42°C. (108°F.) and in January, February average temperatures are 3.3°C. (38°F.), falling at night time occasionally as low as —4°C. (25°F.) (Champion *et al.* 1965). Overall then we have a picture of a very isolated and brackish lake lying in a most inhospitable and harsh environment. Yet, it is a eutrophic body of water supporting a rich and diverse planktonic and micro-crustacean fauna and because of the total absence of any marshy areas or alternative wetlands within a radius of several hundred miles (*sic*) in all directions, Zangi Nawar constitutes a vital staging area for

migrant waterfowl, as well as an important breeding area for a host of unusual Palearctic birds and an impressive number of palearctic wintering visitors.

In two days of survey on January 17th. and 18th 1984, the following estimates of resident winter visiting birds were made (using telescope and tripod and surveying the lake from both shores and by boat).

Blacknecked Grebe (*Podiceps nigricollis*) *c*. 200+, Little Grebe (*Tachybaptus ruficollis*) *c*. 2000+, Great White Egret (*Egretta alba*) 6, Grey Heron (*Ardea cinerea*) 8, Large Cormorant (*Phalacrocorax carbo*) 2, Greylag Goose (*Anser anser*) 1, Common Shelduck (*Tadorna tadorna*) 2, Marbled Teal (*Marmaronetta angustirostris*) *c*. 300, Pintail (*Anas acuta*) 800, Common Teal (*Anas crecca*) approximately 8500, Mallard (*Anas platyrhynchos*) 900+, Gadwall (*Anas strepera*) 500+, Wigeon (*Anas penelope*) 2000, Shoveller (*Anas clypeata*) approximately 7400, Red-crested Pochard (*Netta rufina*) 2, Common Pochard (*Aythya ferina*) 400, Tufted Duck (*Aythya fuligula*) 100+ (total Anatidae approximately 20,900). Longlegged Buzzard (*Buteo rufinus*) 2, Common Buzzard (*Buteo buteo*) 2, unidentified Hen or Pallid Harrier (all females) (*Circus macrourus*) 3, Marsh Harrier (*Circus aeruginosus*) 50+, White-tailed Eagle (*Haliaeetus albicilla*) 1, Peregrine falcon (*Falco peregrinus*) 2, Hobby (*Falco subbuteo*) 1, Waders including Water Rails (*Rallus aquaticus*) estimated 80, Baillon's/Little Crakes (not positively separated) 100+, Moorhens (*Gallinula chloropus*) 400+, Purple Gallinules (*Porphyrio porphyrio*) *c*. 10, Coot (*Fulica atra*) estimated 66,000. Waders including Curlew (*Numenius arquata*) 9, Wood Sandpiper (*Tringa glareola*) *c* 40, Common Snipe (*Gallinago gallinago*) approximately 126, Common Sandpiper (*Tringa hypoleucos*) 4 seen but certainly more numerous. Blackheaded Gulls (*Larus ridibundus*) 7. Passerines including White Wagtail (*Motacilla alba*) and less commonly Yellowheaded Wagtail (*Motacilla citreola*), Moustached Sedge Warblers (*Acrocephalus melanopogon*) extremely numerous, Great Reed Warblers (*Acrocephalus stentoreus*) much less plentiful than Moustached Sedge, Reed Buntings (*Emberiza schoeniclus*) 2 seen. In the tamarisk scrub fringing the shore were numerous Pale Brown Shrikes (*Lanius isabellinus*), Chiffchaff (*Phylloscopus collybita*), and Afghan Babblers (*Turdoides caudatus huttoni*). The author's previous experience and comparison with Kushdil Khan Lake in central Baluchistan revealed a surprising total absence of tern species or of Great Crested Grebe (*Podiceps cristatus*), as well as such birds as Lesser Whitethroats (*Sylvia curruca*) and Wheatears (*Oenanthe* spp.). The absence of Kingfishers (Alcedinidae), Pond Herons (*Ardeola grayii*) and other Egret species is also rather surprising. The striking feature of the winter-time bird populations was the incredible concentration of Coot, blackening the water in some places and in greater total numbers than are currently estimated to occur even on the largest lakes of Sind. Secondly the number of Marsh Harriers visible in the air at one time far surpassed anything previously observed by the author in 34 years of bird watching in Pakistan. A flock of about 75 Marbled Teal flying overhead in a tight pack was also an impressive spectacle for this relatively rare duck. Unfortunately, though a party of Whooper Swans were again reported to have visited the lake in mid-December (Mohammad Rafique, Game Watcher, pers. comm.) they had not stayed more than a few days. There have been no other reliable sightings of any swan species in the sub-continent

within the past 50 years, as far as the author knows.

A second visit from May 3rd to 5th 1984, was made to the lake during which extensive exploration by boat and along the lake margins, was carried out. At this time the lake level was much lower and new reed growth, particularly of *Phragmites* was more extensive. The whole lake seemed to reverberate with the harsh grating songs of *Acrocephalus stentoreus*, the Eurasian Great Reed Warbler, which was conspicuous and abundant in every reed bed. The dominant water birds were now Moorhens (*Gallinula chloropus*) and Dabchicks (*Tachybaptus ruficollis*) both of which appeared to be present in much greater numbers (See Appendix 2) than during the previous January visit. Whiskered Terns (*Chlidonias hybrida*) and Gullbilled Terns (*Gelochelidon nilotica*) were also conspicuous, hunting across the lake in all directions. There were only 2 or 3 Marsh Harriers (*Circus aeruginosus*) all females and the local game watchers asserted that they definitely did not breed, though they would remain on the lake all summer. Christison (1941) thought that Marsh Harriers did occasionally breed on Zangi Nawar. A detailed list of birds observed is given in Appendix 2. The number of Marbled Teal (*Marmaronetta angustirostris*) was only apparent after an extensive boat trip during which pairs were flushed from almost every clump of reeds and it was estimated that the same total wintering population, between 250 or perhaps 300 birds were still on the lake and many pairs starting to nest, courtship chasing and displaying while in the water was constantly observed. There were still small numbers of other bird species which were obviously on passage or non-breeding, such as Wood Sandpiper (*Tringa glareola*), Little Stint (*Calidris minuta*), and Common Sandpiper (*Tringa hypoleucos*). Yellowheaded Wagtails (*Motacilla citreola*) in full breeding plumage and Spotted Flycatchers (*Muscicapa striata*) were also presumed to be on passage. Late lingering ducks included 2 or 3 pairs of Widgeon (*Anas penelope*), also Gadwall (*Anas strepera*) and at least 40 or 50 Shoveller (*Anas clypeata*) and one pair of Common Pochard (*Aythya ferina*). There were now large numbers of Blackwinged Stilts (*Himantopus himantopus*) on the drying out islands in the lake which the local Game Watcher staff stated regularly bred there. The Gullbilled Terns (*Gelochelidon nilotica*) had already started a small nesting colony of 7 pairs on one islet, with one female incubating 2 eggs and much courtship feeding by males bringing fish to their waiting mates. When this islet was approached they flew over our boat and gave rapid-noted threat calls which are never uttered at other times. The Whiskered Terns (*Chlidonias hybrida*) were all in full breeding plumage and frequented another area of the lake which was choked with algae but they did not appear yet to have started nesting. The fact that both these tern species can subsist largely upon aquatic insects and even desert locusts is significant in their choice of this lake for breeding. Perhaps the most surprising discovery was the presence of at least 12 pairs of Whitetailed Lapwings (*Vanellus leucurus*) defending territory aggressively against other waders and performing nuptial display flights with every indication that they were settling down to breed, though no nests could be located. Similarly there were between 30 and 40 White-eyed Pochard (*Aythya ferina*) most of them in pairs and with the males constantly displaying and calling, though difficult to observe in the reed beds which they frequented. Again two game watchers asserted that a large number of pairs of this pochard bred on the lake each year (Mohammed

Rafique and Noor Mohammed, pers. comm.). Despite late evening patrolling of the lake on two nights no evidence of any crakes or rails still being resident was obtained, though female Painted Snipe (*Rostratula benghalensis*) were calling from several reed beds. There were also numerous Little Bitterns (*Ixobrychus minutus*), which had not yet settled down to breed but were regular summer visitors according to the game watchers. In one small reed bed as many as 5 Little Bitterns together were flushed. The Coot (*Fulica atra*) was much less numerous than Moorhens, but still numbered about 2000 birds and according to the local Forestry Staff at least 6 or 700 pairs nested on the lake each year. In Ali and Ripley's HANDBOOK Volume 3, it is stated that Coots regularly breed in Sind. However during over 30 years of bird study and egg collecting throughout Sind, Kenneth Eates only had 2 or 3 records of pairs nesting and all of these were from one lake, Manchar Lake in Dadu District in the late 1940's. Similarly Meinertzhagen (1920) and Christison (1942) reported that Coot only very rarely nested on Kushdil Khan Lake in Pishin district.

The few Large White Egrets and Grey Herons observed, were not in nuptial plumage but were presumed to be year round residents. Collared Sand Martins (*Riparia riparia*), feeding over the lake had not been observed in January and previous observers (Meinertzhagen, *Ibis* 1920) believed that they regularly breed in Baluchistan. Considerable numbers of Bluecheeked Bee-eaters (*Merops superciliosus persicus*) were hunting around the lake environs and also regularly breed there, according to the Forestry staff.

Perhaps the two most interesting breeding birds discovered were the Whitetailed Lapwings and Ferruginous or White-eyed Pochard. The total absence of any Blacknecked Grebes (*Podiceps nigricollis*) or Acrocephalines other than *A. stentoreus* was by contrast, rather disappointing.

Discussion of Survey findings

In central Asia and the Middle East both the Whiteheaded Duck (*Oxyura leucocephala*) and the Marbled Teal (*Marmaronetta angustirostris*) are probably the most endangered Anatidae of the region. Pakistan is probably second only to Turkey in importance as a wintering ground for *Oxyura* and the bulk of the entire population which visits the sub-continent usually winters on Khabbaki Lake in the Punjab Salt Range which has already been declared a Sanctuary. Similarly, Zangi Nawar may be only second in importance to the marshes of the Tigris Euphrates in Iraq for Marbled Teal. Altogether six major wetlands in Pakistan three of them in Sind province, have been listed as of major importance under the Ramsar Convention (1971), to which Pakistan is a signatory nation. No lakes in Baluchistan have been included within these six.

Fortunately since last year 1983, Zangi Nawar Lake has been declared a Game Sanctuary by the Baluchistan Government. As the only known wetland on the sub-continent which has been visited by Whooper Swans in recent decades and as the breeding home of probably the major population of Marbled Teal anywhere within the region including adjacent Afghanistan and Iran, it is therefore a wildfowl refuge of international importance and deserves to be recognised as such. Whilst holding an impressive total of wintering duck and Rallidae (estimated 22,000 duck and 66,000 Coot), according to the reports of all local observers and Forestry Department officials, the number of birds occurring on the lake dur-

ing autumn and spring passage is more than double the mid-winter totals (K. M. Shams, Chief Conservator of Forests, Government of Baluchistan, pers. comm.). It is the only known locality where the Whitetailed Lapwing (*Vanellus leucurus*) breeds, besides, having an amazingly high breeding population of dabchicks, coots and moorhens.

At present due to lack of funds, the Government of Baluchistan has only been able to appoint 4 game watchers (Forestry Department employees equivalent to wardens). They are without transport facilities or such equipment as binoculars and it is to be hoped that some international conservation organisations may be able to assist with funds to strengthen the protection needed for this lake. During both visits there was ample evidence of illegal shooting on islets in the lake, both in the form of recently constructed gun butts, remains of campfires and cigarette packets, and during the January visit distant gun shots were heard across the lake. Afghan refugees on the western borders of the lake can only be reached after nearly half a day's camel ride and the inability to control poaching is no reflection on the enthusiasm or integrity of the limited number of game watchers posted at Zangi Nawar.

Mammals noted, and positively identified around the lake included Jackal (*Canis aureus*), Brushfooted Jerboas (*Jaculus blanfordi*) and Desert Pipistrelles (*Pipistrellus kuhli*). Reptiles seen and identified (Minton 1966) included the Transcaspian Desert Monitor Lizard (*Varanus caspius*), the Yellowspeckled Toad Agama (*Phrynocephalus luteoguttatus*), the Turkestan Platetailed Gecko (*Teratoscincus scincus*), the Reticulate Desert Lacerta (*Eremias acutirostris*) and the Leafnosed Viper (*Eristicophis macmahoni*).

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Appendix I

Chemical Analysis of Water from Zangi Nawar Lake

Description	..	Slightly pale liquid with sedimented particles of soil having a saline taste.
pH	..	9.2
Total solids	..	7.2760 gm/litre
Hardness as $CACO_3$	..	8.0 mg $CaCo_3$/litre
Sulphates	..	2.5765 gm/litre
Chlorides	..	1.0652 gm/litre
Magnesium	..	0.8048 gm/litre
Calcium	..	0.2145 gm/litre
Total Carbonates	..	9.02 mg/litre
Total Bicarbonates	..	48.13 mg/litre

Appendix II

List of Birds observed during Survey May 3 to 5th 1984

		Estimated Numbers	Probable Breeding
1.	Little Grebe (*Tachybaptus ruficollis*)	4000 +	x
2.	Large Cormorant (*Phalacrocorax carbo*)	1	
3.	Grey Heron (*Ardea cinerea*)	6	?
4.	Large Egret (*Egretta alba*)	2	?
5.	Little Bitten (*Ixobrychus minutus*)	30 +	x
6.	Spoonbill (*Platalea leucorodia*)	2	?
7.	Marbled Teal (*Marmaronetta angustirostris*)	250 +	x
8.	Gadwall (*Anas strepera*)	2	
9.	Wigeon (*Anas penelope*)	4	
10.	Shoveller (*Anas clypeata*)	45 +	
11.	Common Pochard (*Aythya ferina*)	2	
12.	White-eyed Pochard (*Aythya nyroca*)	30 +	x
13.	Marsh Harrier (*Circus aeruginosus*)	3	
14.	Moorhen (*Gallinula chloropus*)	4500 +	x
15.	Purple Gallinule (*Porphyrio prophyrio*)	20 +	x
16.	Coot (*Fulica atra*)	2000	x
17.	Painted Snipe (*Rostratula benghalensis*)	6 +	x
18.	Blackwinged Stilt (*Himantopus himantopus*)	25	x
19.	Whitetailed Lapwing (*Vanellus leucurus*)	25	x
20.	Little Ringed Plover (*Charadrius dubius*)	6	
21.	Kentish Plover (*Charadrius alexandrinus*)	20 +	x
22.	Blacktailed Godwit (*Limosa limosa*)	7	
23.	Wood Sandpiper (*Tringa glareola*)	30 +	
24.	Common Sandpiper (*Tringa hypoleucos*)	10 +	
25.	Little Stint (*Calidris minuta*)	50 +	
26.	Whiskered Tern (*Chlidonias hybrida*)	24	x
27.	Gullbilled Tern (*Gelochelidon nilotica*)	15 +	x
28.	Indian Ring Dove or Collared Dove (*Streptopelia decaocto*)	8	x
29.	Common Kingfisher (*Alcedo atthis*)	1	
30.	Bluecheeked Bee-eater (*Merops superciliosus*)	300 +	x
31.	European Roller (*Coracias garrulus*)	1	
32.	Hoopoe (*Upupa epops*)	2	x
33.	Hoopoe Lark (*Alaemon alaudipes*)	6	x
34.	Collared Sand Martin (*Riparia riparia*)	15	x
35.	Swallow (*Hirundo rustica*)	45	x
36.	Rosy Pastor (*Sturnus roseus*)	4	
37.	Afghan Babbler (*Turdoides caudatus huttoni*)	100 +	x
38.	Spotted Flycatcher (*Muscicapa striata*)	2	
39.	Great Reed Warbler (*Acrocephalus stenoreus*)	800 +	x
40.	Booted Warbler (*Hippolais caligata*)	30 +	x
41.	Yellowheaded Wagtail (*Motacilla citreola*)	6 +	
42.	Tree Sparrow (*Passer montanus*)		x
43.	Whitethroated Munia (*Lonchura malabarica*)		x

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OBSERVATIONS ON THE BIOLOGY OF *HAEMAPHYSALIS SPINIGERA* NEUMANN, 1897 (ACARINA: IXODIDAE) UNDER NATURAL CONDITIONS IN KFD AREA[1]

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The bionomics of *Haemaphysalis spinigera* vector of KFD virus was studied under natural conditions in KFD area. Engorged females crawled under ground cover and deposited their eggs in the humus. Oviposition commenced 5 to 11 days after the release and continued for 10 to 17 days. Eggs hatched after 25 to 52 days. Larvae remained dormant in clusters under the litter throughout the rainy season, became active and appeared on the litter and vegetation soon after the end of rainy seasons. Some larvae survived as long as 230 days.

Engorged larvae settled under the litter for moulting. Nymphs emerged and appeared on the litter and vegetation 22 to 29 days after larval release. No dormancy was observed in nymphs in any season. Some nymphs survived as long as 178 days.

Engorged nymphs dispersed and settled under the litter for moulting. Adults emerged 24 to 35 days after nymphal release. Adults that emerged during the dry months remained dormant under the litter until the onset of the monsoon, while those that emerged during monsoon months dispersed and settled on plants without undergoing dormancy. Dormant adults could be induced to activity by spraying water on the litter. Some adults survived as long as 278 days.

INTRODUCTION

The definitive role of *Haemaphysalis spinigera* as the chief vector of Kyasanur Forest disease (KFD) virus has been established on the basis of isolation of the virus from naturally infected ticks, evaluation of vector potentials under laboratory conditions and the prevalence of the species on forest vegetation, monkeys and man (Varma *et al.* 1957, Trapido *et al.* 1959, Boshell *et al.* 1968, Varma *et al.* 1960, Rajagopalan *et al.* 1968a, Trapido *et al.* 1964, Rajagopalan and Anderson 1971, and VRC unpublished data). Despite the above fact, other aspects of KFD epidemiology, particularly the ecology of *H. spinigera* under natural conditions, has been poorly studied except for some information on the seasonal abundance of different stages on the forest floor and on vertebrate hosts (Rajagopalan *et al.* 1968a & b, Trapido *et al.* 1964, Rajagopalan and Anderson 1971, Rajagopalan 1972, and Bhat 1974).

Taking the importance of the information on the bionomics of the vector species into consideration, particularly for better understanding the epidemiology and for designing the control measures, a detailed study on the bionomics under natural conditions was undertaken. This communication presents the results of the study.

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Materials and methods

General considerations:

H. spinigera is a three host obligatory range parasite with three long free living phases as larva, nymph and adult and three brief parasitic phases of 2 to 7 days each for larva and nymph and 6 to 16 days for adult. The three parasitic and free living phases alternate with each other (Bhat 1979). The free living phases which are of long duration are spent in the forest environment. The free living phases are totally subjected to the environmental conditions in the forest and their behaviour pattern is directed to shelter seeking, development, survival during unfavourable conditions and to host seeking.

As per the available references (Rajagopalan *et al.* 1968a & b) the adults appear on the vegetation and mammalian hosts after the commencement of monsoon showers and continue their activity till the end of monsoon and gradually decline by the end of December. Larvae appear on the vegetation and mammalian hosts a couple of weeks after the cessation of the monsoon, reach a peak density in October and November and gradually decrease henceforth. Nymphs appear in November, reach a peak density in January and February and gradually decrease in the summer months.

Rearing:

Adults collected from forest vegetation in the KFD area were used to initiate a laboratory colony. They were fed on calves in metal capsules. Larvae obtained from these females were reared to adults and a colony was established. Larvae and nymphs were fed on calves, white bellied rats (*Rattus rattus wroughtoni*), Blanford's rats (*Rattus blanfordi*), jungle striped squirrels (*Funambulus tristriatus tristriatus*) and white leghorn chicks.

Field studies:

Studies on the development, metamorphosis and behaviour of ticks were conducted by releasing appropriate stages in the forest, followed by sequential observations. Unengorged ticks were taken to Sagar Field station where they were fed on calves. Engorged females were collected, washed to remove the blood stains, marked with a dot of plastic acrylic paint on the dorsal surface posterior to the scutum and released on the forest floor at the experimental site. A group of 24 ticks was released with a meter long nylon thread fixed on the dorsal surface of each tick to facilitate tracing and observations. Three different microhabitats were selected to study the engorged adults through to the larvae; two in the forest and one in the grazing ground. The first forest habitat had thick forest litter overlying loose humus and was shaded with thick forest canopy and undergrowth. The second forest habitat had a discontinuous canopy and was more exposed to sunlight and the floor covered with thin litter intermingled with forest grass.

Larval behaviour was studied by observing the larvae hatched out from the eggs laid by engorged females released, by observing larvae hatched out from the eggs deposited or by releasing larval broods as such. A number of larval broods from natural population were also observed. The metamorphosis of fed larvae into nymphs and the behaviour of fed larvae and unfed nymph were studied by observing the released engorged larvae and questing nymphs.

Similarly the phase from engorged nymphs to questing adults was studied by releasing engorged nymphs and following the subsequent events till the death of the questing adults. As nymphs and larvae could not be marked, there was no way to distinguish the introduced ticks from natural population; but as far as possible

the experimental areas were cleaned off of questing ticks by repeated flag draggings before the release. Proportionately large number of ticks released in each experiment made the observation more reliable. Further, the limited horizontal migration, formation of clusters of large number of larvae and nymphs and the persistence of clusters on the foliage tips also made possible the sequential follow up and step by step observations.

Study area :

All the studies were carried out in a small patch of (3 hectares) thick semievergreen forest at Bhimneri village situated on the western side of Sagar-Sorab road, about 3 miles north of Sagar. An area of about 500 sq. metres was fenced with closely set barbed wire so as to exclude larger mammals. Within this, five shady stations each of 2 sq. m. were prepared by isolating the area with rectangular metal moats fixed on the ground. The physical structure consisting of a cluster of plants and the litter was kept undisturbed. In order to prevent the lateral spread of ticks, the moats were filled with water during the study. Birds were kept away by enclosing the stations with nylon nettings. A part of the study pertaining to longevity and behaviour was done inside these stations .

The temperature and humidity of the biotopes were recorded as frequently as possible with a whirling psychrometer. A thermophil was used to measure the temperature of the humus. Standardized cobalt chloride papers were used for estimating relative humidity of the litter.

Description of the area :

The activity of the KFD virus is restricted to the Malnad areas of Shimoga and North Kanara districts of Karnataka state. Situated in the zone of heavy rainfall the area receives about 150 to 400 cm. annual rainfall mainly between June and September. There is a sharp reduction in rainfall from west to east. The year may be roughly divided into four seasons: Wet southwest monsoon from June to September, Postmonsoon warm weather from October to November, Cold weather from December to February and hot weather from March to May.

The air remains humid during monsoon months and dry during March to May. From October to February days remain dry but nights remain wet from heavy dew or fog.

The meteorological records at Sagar shows that monthly mean maximum temperature during the hottest month (April) rarely goes above 38°C. The maximum temperature occasionally reaches 40°C. The daily range of temperature is large during dry months and small during monsoon months. The coldest months are December and January. The monthly mean minimum temperature reaches as low as 12°C. The daily minimum temperature recorded so far is 9°C.

The temperature and humidity fluctuations inside the forest are lesser than that of open areas. The litter remains almost saturated with moisture from June to March. From April to May the humidity usually falls during day and reaches saturation during most of the nights. The temperature in the litter varies from 17.5°C to 25°C.

The KFD area has a number of diverse biotopes such as forest, cultivated valleys and grasslands. Each biotope is distinguished into a number of associations. These associations are interspersed to form a mosaic. The forest biotope which provides the necessary physical and biotic environment forms the main habitat of the tick fauna. The forest biotope is divisible into three types, which are: semievergreen, semideciduous and deciduous. These

three types are found adjacent to each other forming a mosaic. Delineation of the types is not clear cut, because they merge with each other and produce a transitional strip of ecotones. Along the border between the forests and the grasslands there is usually an ecotone of scrub or thickets. The grassland is usually dotted with small patches of vegetation, sometimes forming impenetrable clumps.

The forest floor is covered by a thick mantle of forest litter under which the ticks spend their period of development, matamorphosis and dormancy. The litter consists of leaves and sticks in various stages of decay. The main bulk of the litter is built up in the postmonsoon and cold weather months. Leaf-fall in various plants starts in the beginning of post-monsoon months and continues till the end of March. The litter attains its maximum thickness just before the onset of monsoon and the main bulk of the litter is reduced into humus in monsoon and post-monsoon months.

A large number of wild mammals and birds inhabit the forest. These with the large number of domestic cattle and buffaloes form the host fauna for the ticks.

Observations

Engorged females:

Seventyeight adults were released in 13 lots, each consisting of 4 to 13 individuals at different points in the forest habitat between 26 September and 10 October, 1963. These ticks, the eggs laid by them and the larval progeny were observed till 23rd March, 1964 (Table 1). Of these 54 ticks released without nylon threads 32 laid eggs and rest could not be traced. Of the 24 ticks released with nylon threads 18 laid eggs and died subsequently. Remaining 6 ticks could not be traced.

Fortyfive ticks were released in 9 lots, each consisting of 5 ticks, between 4 June 1964 and 8 June 1965 (Table 2). Before releasing, they were thoroughly washed to remove blood stains to keep away the predator ants, as the blood stain was found to attract the ants. All the ticks laid eggs and died subsequently. The sequence of various events were followed till the larval progeny disappeared, the last one in February 1966.

The engorged females, as soon as released on the ground cover, began to seek their way downwards, crawling slowly and moving their forelegs. They dragged themselves under the litter out of sight within 5 to 10 minutes. Progression ceased as soon as they came in contact with underlying hard soil or humus. Ticks released on the grazing ground also moved horizontally till they reached dark places under the grass cover. Ticks released during monsoon months came to rest just below the litter and laid eggs on the surface of humus. Those released during dry months from October to June showed a marked burrowing behaviour. After reaching the humus they dug up small pits with their hypostome and forelegs and burrowed themselves leaving only the posterior end exposed. The eggs were laid inside these pits.

The lateral and downward progression, including burrowing, was confined to the first one or two days unless the resting tick was disturbed. The direction of the movement was zig-zag and at random.

The distance travelled between the release point and egg laying site was measured for 23 ticks. Two ticks were found ovipositing at a distance of 27.5 cm, 2 at 25 cm, 3 at 22.5 cm, 1 at 20 cm, 4 at 17 cm, 2 at 16 cm, 1 at 15 cm, 1 at 13.5 cm, 1 at 12.5 cm, 5 at 10 cm, and 1 at 7.5 cm. All the other ticks were found laying eggs within a distance of 30 cm from the place of release.

TABLE 1

H. spinigera, VARIOUS EVENTS FROM ENGORGED FEMALE THROUGH LARVAE IN KFD AREA — 1963

Group	No. of ticks	Date released	No. of ticks oviposited	No. of ticks lost	Date oviposition began	Date oviposition ended	Date hatching began	Date hatching ended	Date lateral spread began	Dormancy in days	Date larvae disappeared	Life span in days
1	5	26.9.63	3	2	2.10.63	16.10.63	28.10.63	14.11.63	15.11.63	18	30.1.64	94
2	8	26.9.63	2	6	2.10.63	16.10.63	28.10.63	14.11.63	15.11.63	18	7.2.64	102
3	13*	†27.9.63	10	3	2.10.63	16.10.63	28.10.63	14.11.63	15.11.63	18	23.1.64	87
4	6*	27.9.63	5	1	3.10.63	18.10.63	29.10.63	16.11.63	15.11.63	17	15.2.64	107
5	4	28.9.63	3	1	4.10.63	20.10.63	29.10.63	16.11.63	15.11.63	17	21.2.64	115
6	5	8.10.63	2	3	4.10.63	20.10.63	29.10.63	16.11.63	15.11.63	17	21.2.64	115
7	5	8.10.63	5	0	16.10.63	30.10.63	20.11.63	5.12.63	28.11.63	8	23.3.64	124
8	4	8.10.63	1	3	16.10.63	30.10.63	20.11.63	5.12.63	28.11.63	8	16.3.64	117
9	4	8.10.63	3	1	17.10.63	30.10.63	21.11.63	6.12.63	28.11.63	8	9.3.64	109
10	7	9.10.63	6	1	17.10.63	2.11.63	21.11.63	6.12.63	28.11.63	8	30.3.64	130
11	5	10.10.63	2	3	18.10.63	3.11.63	18.11.63	3.12.63	28.11.63	10	9.3.64	112
12	6	10.10.63	5	1	18.10.63	3.11.63	21.11.63	6.12.63	28.11.63	7	2.3.64	102
13	6	10.10.63	3	3	18.10.63	3.11.63	21.11.63	6.12.63	28.11.63	7	9.3.64	109

* Released with threads.
† Released on grazing ground.

TABLE 2

H. spinigera VARIOUS EVENTS FROM ENGORGED FEMALE THROUGH QUESTING LARVAE IN KFD AREA — 1964 & 1965

Group	No. of ticks	Date released	Date oviposition began	Date oviposition ended	Date hatching began	Date hatching ended	Date larval spread began	Date larvae appeared on plants	Dormancy in days	Date larvae disappeared	Life span in days
1	5	4.6.64	13.6.64	26.6.64	15.7.64	25.7.64	7.10.64	13.10.64	89	30.1.65	199
2	5	1.7.64	7.7.64	20.7.64	12.8.64	19.8.64	10.10.64	15.10.64	59	29.1.65	170
3	5	2.8.64	8.8.64	23.8.64	15.9.64	25.9.64	10.10.64	14.10.64	26	15.2.65	153
4	5	28.8.64	5.9.64	15.9.64	15.10.64	24.10.64	17.10.64	23.10.64	2	18.2.65	126
5	5	29.9.64	4.10.64	14.10.64	16.11.64	21.11.64	19.11.64	20.11.64	3	21.2.65	97
6	5	20.10.64	28.10.64	13.11.64	10.12.64	26.12.64	17.12.64	19.12.64	7	29.2.65	81
7	5	20.11.64	28.11.64	15.11.64	18.1.65	29.1.65	22.1.65	24.1.65	4	13.4.65	85
8	5	22.7.64	2.1.65	17.1.65	20.2.65	7.3.65	21.2.65	25.2.65	3	27.6.65	127
9	5	8.6.65	14.6.65	25.6.65	12.7.65	20.7.65	28.8.65	28.8.65	47	15.2.66	218

The bluish-black colour of freshly fed ticks changed to black on the second day and was maintained until oviposition commenced. Pre-oviposition phase varied from 5 to 11 days (Tables 1 and 2). During dry months, when the temperature under the litter was low (17 $\pm$ 1°C) preoviposition phase varied from 8 to 11 days. In open areas they began to lay eggs on 5th day. During rainy season when the humus temperature was slightly higher (21 $\pm$ 1°C) it varied from 5 to 8 days. No locomotion was observed during oviposition and each female laid all eggs in a single mass.

Oviposition continued for 10 to 17 days. As oviposition progressed ticks underwent a size reduction and change in colour. At the end of oviposition the colour was rusty brown. Among ticks missing before oviposition, 4 were seen being dragged by ants. All the dead spent ticks were attacked by ants.

Eggs:

Duration of incubation period varied from 30 to 52 days during dry months and 25 to 40 days during wet months. On the grazing field development was observed only from October to December. During monsoon months females and their broods were washed away by rain water and from January to May the eggs shrivelled up under the hot sun.

Larvae:

Three broods consisting of 1 to 11 day old eggs deposited under the litter on 23 July 1963 hatched between 18 and 28 August. Larvae crawled up and clung in a compact mass to the undersurface of a dry leaf of the litter, just above the egg ghosts. The cluster remained stationary for about a month, except for gradual shifting over to a contiguous leaf, but the movement was confined within 2 to 4 cm. On 23 September all 3 broods had begun to dissoeiate into small clusters distributed within a radius of 7 to 10 cm. During this process a few larvae crawled over to neighbouring leaves. On the morning of 24 September the larvae of caeh brood had reformed into 2 to 3 larger clusters and during warm day hours they again began to dissociate. By evening each cluster had further split into 2 to 3 smaller elusters and the area covered had widened. The process continued through 26th, and on 27th morning larvae had moved on the surface and had formed numerous smaller clusters of 10 to 300 larvae on the tips of leaves and on the stems of surface vegetation. The brood had covered a radius of 30 cm. The activity coincided with a week's interruption in rainfall and the drying of the litter. On 28 morning, following heavy shower the previous evening, most of the larval clusters that settled on the vegetation were not to be found. But on 29 morning many larvae returned to the leaf-tips, and formed numerous small clusters of 10 to 25 larvae dispersed in a radius of about 45 cm.

During the following days larvae on stems and sticks kept on crawling until they reached undersurfaces of horizontal leaves and grass blades where they finally settled. During this movement the area occupied by the brood increased until nearly all larvae settled under leaves. Clusters settled on leaf-tips withdrew to the lower surface on rainy days and re-occupied the tips as soon as the environment dried. Larvae from these broods survived till 10 Deeember 1963.

A brood of eggs laid between 1 and 14 September 1963 was introduced under the litter on 15 September. Hatching began on 5 October. As hatching progressed, larvae formed 3 clusters and clung to the undersurface of a leaf immediately overlying the egg ghosts. Hatching was completed after 10 days and the 3 larval clusters combined into a single large

mass, which went on rolling and shifting position within a radius of 5 cm. On 16 October the brood segregated and on the following days dispersed and and settled on the vegetation in small clusters. This population gradually tapered and disappeared on 13 January 1964.

Three 7 to 17 day old broods were deposited under the litter on 20 December 1963. On third day all the broods were found shrivelled up.

A 10 to 20 day old brood was placed under the litter on 10 June 1964. Frequent showers kept the litter constantly wet. Hatching began on 16 July and the larvae settled under the litter in a compact mass with a thin film of water. On 24 August this broke into three clusters resting under three different leaves close by and stayed as such till 6 October. On 6 October part of the brood appeared on the vegetation. Rest of the larvae followed and settled on the plants until 14 November.

Nine laboratory-hatched broods were deposited under litter between June 1964 and March 1965 (Table 3). Seven broods released during rainy season stayed under litter in compact clusters held in thin films of water. They became active in the third week of October and dispersed and settled on vegetation. The last 2 broods released on 12 November 1964 and 10 March 1965, immediately commenced their activity and settled on the vegetation. During November and December 1964, 8 more larval broods were released. They dispersed and settled on plants without undergoing dormancy.

Larval progeny from engorged females introduced in 1963, 1964, and 1965 were also studied (Tables 1 and 2). Larval broods from groups 1 to 6 emerged from the litter and appeared on vegetation 16 to 18 days after commencement of hatching and those of groups 7 to 13 after 7 to 10 days after hatching.

Larvae from groups 1 to 3 of ticks released in 1964 stayed under the litter in dormant condition throughout the rainy season (Table 2). They became active in the 2nd and 3rd week of October and settled on plants during the following weeks. Larvae from groups 4 to 8 hatched at the end of the monsoon, soon dispersed and settled on the vegetation. Larvae from group 9 released on 8 June 1965, began to hatch on 12 July and stayed under litter for 47 days under dormancy before dispersing.

TABLE 3

H. spinigera, VARIOUS EVENTS IN LARVAL BROODS RELEASED IN KFD AREAS

Group	Larval age in days	Date released	Date activity began	Dormancy in days	Maximum distance in inches covered in 30 days	Date larvae disappeared
1	14-30	10.6.64	18.10.64	130	72	30.1.65
2	8-22	15.7.64	18.10.64	95	70	4.2.65
3	3-18	13.8.64	13.10.64	63	49	2.2.65
4	1-15	1.9.64	17.10.64	42	80	4.2.65
5	1-15	15.9.64	17.10.64	32	49	4.2.65
6	1-14	21.9.64	17.10.64	26	56	8.3.65
7	3-13	30.9.64	22.10.64	22	70	8.3.65
8	3-13	12.11.64	13.11.64	0	80	8.3.65
9	10-25	10.3.65	11.3.65	0	45	19.5.65

Tiny clusters appeared on plants on 28 August, when there was a week's interruption in the rain, but these larvae were washed down during the subsequent rains. All the above broods started their activity suddenly at the end of September, dispersed and settled on the plants.

Survival of larvae :

Clusters from broods hatched during June and July stayed longer than those hatched during later months (Tables 1 and 2). Larvae hatched in October and November disappeared from vegetation by the end of March. The persistence was for 80 to 130 days. Larvae that hatched in rainy season and stayed dormant for a considerable period survived for 150 to 230 days. Irrespective of the time of hatching, all the broods settled on the vegetation after the monsoon disappeared before the end of March.

Engorged larvae :

Twenty one groups of freshly engorged larvae, each with 200 or 300 specimens, were released in different microhabitats in different seasons from December 1963 to June 1965 (Table 4).

Immediately after release, they crawled in all directions at random. On forest litter they crawled along the upper surface of the super-

TABLE 4

H. spinigera, VARIOUS EVENTS FROM ENGORGED LARVAE THROUGH QUESTING NYMPHS IN KFD AREA

Group	Microhabitat	No. larvae in group	Date released	Date nymphs appeared on litter	No. nymphs recovered during first 15 days*	Life span in days
1	Thick forest litter	200	31.12.63	28.1.64	124	61
2	Thick forest litter	200	31.12.63	28.1.64	156	61
3	Thick forest litter	200	31.12.63	28.1.64	149	61
4	Thick forest litter	200	31.12.63	28.1.64	77	61
5	Thick forest litter	200	29.5.64	26.6.64	—	178
6	Thick forest litter	200	27.6.64	23.7.64	—	148
7	Thick forest litter	200	1.8.64	27.8.64	—	116
8	Thick forest litter	200	1.9.64	29.9.64	49	94
9	Thick forest litter	300	14.9.64	13.10.64	—	37
10	Thick forest litter	300	28.9.64	20.10.64	82	69
11	Grazing ground	200	28.9.64	20.10.64	8	—
12	Grazing ground	200	28.9.64	20.10.64	53	69
13	Grazing ground	200	28.9.64	20.10.64	3	—
14	Forest edge	200	28.9.64	20.10.64	51	69
15	Grazing ground	300	14.11.64	9.12.64	2	—
16	Grazing ground	300	14.11.64	9.12.64	1	—
17	Thick forest litter	300	14.11.64	13.12.64	205	84
18	Thick forest litter	300	14.11.64	13.12.64	160	84
19	Grazing ground	300	17.6.65	10.7.65	3	—
20	Thick forest litter	300	17.6.65	11.7.65	89	—
21	Thick forest litter	300	23.6.65	18.7.65	136	—

* No ticks were recovered after this time and those recovered were subsequently released for longevity study.

ficial leaves. After reaching the edges some dropped to lower layers and some crawled along the lower surface. Subsequently all of them penetrated the litter and settled in the humus after 4 to 6 hrs. They remained sensitive for 5 to 8 days and could be induced to move by slight disturbance. Later they became inactive and passed on to the moulting phase. Moulting larvae were traced under deep layers of litter and loose humus, and were seen hidden inside crevices and cavities of mud lumps. They could penetrate as deep as 2 cm into the loose humus. Centripetal search in small sectors revealed that larvae had moved only 20 to 30 cm away in search of shelter.

Larvae released in the forest during monsoon months settled on the superficial layers of litter. Larvae released on grazing ground during dry months settled under grass and in earth crevices, of which only a small proportion was recovered as nymphs. Larvae released on grazing ground during rainy seasons were washed away and there was no recovery of nymphs. On the forest edge, where the ground was covered with a thin layer of litter mixed with grass, a small proportion of nymphs was recovered (Table 4).

Larval moulting:

Larvae moulted into nymphs 22 to 29 days after the release (Table 4). Freshly emerged nymphs appeared on vegetation soon after moulting. Larvae released on more exposed areas moulted earlier than those on less exposed areas. Larvae released during monsoon months moulted earlier than those released at other months.

Nymphs:

Nymphs appeared on vegetation and on the litter soon after moulting irrespective of season. Freshly moulted nymphs containing traces of larval blood meal emerged on the surface. Emerging nymphs from some groups were recovered periodically to estimate the proportion of larvae moulted into nymphs. They were re-released in other places to study their longevity. The recovery of nymphs inside the forest was 24 to 78 per cent. The grazing field was most unfavourable niche for larval moulting and only up to 4 per cent recovery could be made, except in one group which yielded 25.5 per cent nymphs (Table 4).

Survival of nymphs:

Nymphs survived on litter and on vegetation for a maximum span of 6 months (Table 4). Though nymphs emerged early in the rainy months, they could survive for 3 to 6 months. The mortality rate was higher due to heavy rain.

Engorged nymphs:

A total of 10.725 freshly fed nymphs was introduced into different microhabitats of the forest biotope in 36 groups each having 50 to 2,000 individuals between December 1963 and June 1965. Thirty two groups were released during dry season from October to May, the period of nymphal activity and four were released during rainy season (Table 5).

When released, engorged nymphs crawled at random in all directions seeking a way into the deeper layers of litter. Underneath the litter they settled at different depths in litter and humus. They could be traced as deep as 2.5 cm in the humus. The activity ceased 24 to 48 hours after the release. When disturbed by lifting the litter cover and exposing to light, they resumed their activity which ceased when again they found a shelter. The activity totally ceased when they entered the moulting phase after 7 to 10 days.

During dry months the nymphs settled in the

H. spinigera, VARIOUS EVENTS FROM ENGORGED NYMPHS THROUGH QUESTING ADULTS IN KFD AREA

Group	No. in group	Date released	Adults moulted after days	Date adults appeared on plants	Dormancy in days	Maximum no. ticks recorded Date	Maximum no. ticks recorded No.	Percentage recovery	Days ticks persisted on plants
1	50	19.12.63	29	12.6.64	147	22.6.64	4	8.0	129
2	50	25.12.63	28	—	—	—	0	0.0	—
3	200	17.1.64	33	21.6.64	123	9.7.64	8	4.0	80
4	100	31.1.64	31	15.6.64	105	28.7.64	22	22.0	210
5	200	10.2.64	34	16.6.64	93	16.7.64	8	4.0	—
6	200	10.2.64	34	16.6.64	93	28.7.64	80	40.0	228
7	200	10.2.64	34	16.6.64	87	16.7.64	28	14.0	—
8	200	10.2.64	34	10.6.64	87	16.7.64	102	51.0	278
9	200	12.2.64	35	24.6.64	98	16.7.64	12	6.0	—
10	200	12.2.64	35	16.6.64	90	1.7.64	11	5.5	—
11	200	12.2.64	35	Burnt by forest fire		—	—	—	—
12	200	12.2.64	35	Burnt by forest fire		—	—	—	—
13	200	13.2.64	34	25.6.64	99	16.7.64	3	1.5	—
14	200	13.2.64	34	16.6.64	90	16.7.64	12	6.0	—
15	200	13.2.64	34	Burnt by forest fire		—	—	—	—
16	2000	17.2.64	—	Burnt by forest fire		—	—	—	—
17	300	19.2.64	35	10.6.64	77	28.7.64	16	5.3	233
18	300	19.2.64	35	10.6.64	77	21.7.64	44	14.7	243
19	300	19.2.64	35	5.6.65	72	29.6.64	53	17.7	248
20	1000	19.2.64	30	12.6.64	84	19.6.64	3	0.3	—
21	200	9.4.64	24	12.6.64	40	12.6.64	1	0.5	27
22	500	14.5.64	24	23.6.64	6	29.6.64	4	0.8	122
23	125	19.6.64	—	—	—	—	—	0.0	—
24	200	13.10.64	28	17.11.64	7	17.11.65	14	7.0	—
25	100	13.11.64	26	8.6.65	181	8.6.65	1	1.0	—
26	100	13.11.64	26	8.6.65	181	22.6.65	22	22.0	—
27	200	16.11.64	27	8.6.65	177	22.6.65	152	76.0	—
28	500	12.11.64	33	8.6.65	145	22.6.65	303	60.8	—
29	300	18.2.65	28	8.6.65	82	29.6.65	97	32.3	—
30	200	15.3.65	31	8.6.65	54	22.6.65	149	74.5	—
31	300	15.3.65	31	8.6.65	54	15.6.65	106	35.3	—
32	400	15.3.65	31	8.6.65	54	22.7.65	214	53.5	—
33	300	18.3.65	30	8.7.65	52	6.7.65	135	45.0	—
34	200	11.6.65	25	8.7.65	2	20.7.65	4	2.0	—
35	400	11.6.65	25	8.7.65	2	20.7.65	113	28.2	—
36	200	15.6.65	26	13.7.65	2	20.7.65	24	12.0	—

deeper layers of litter or humus. They were seen in the crevices, cavities in the lumps of mud, and between decomposing leaves. During rainy season they were traced in the superficial layers of the litter. On grazing land they settled in the crevices, but were either desiccated during dry months or were washed away during monsoon months. The dispersal was as far as 30 cm from the point of release. A large number of nymphs were predated by forest ants, particularly from group nos. 5, 7 and 10.

Nymphal moulting:

Nymphs moulted into adults 24 to 35 days after release (Table 5). Each batch took 2 to 5 days to complete the moulting.

Dormancy in adult ticks:

Adults moulted between December 1963 and May 1964 remained dormant during the entire dry season under the litter (Table 5). Clusters of 2 to 10 individuals were observed under individual leaves in the litter. However light activity was observed during summer showers — ticks resting under deeper layers of litter and humus crawled up to the superficial layers. No significant lateral dispersal or emergence from the litter was observed. Similarly adults from nymphs released from November 1964 to March 1965 spend the entire dry period in a state of dormancy under the litter. However 2 to 5 individuals from each batch emerged from the litter and climbed the plants after a heavy premonsoon shower (Table 5). Adults that moulted from June to mid-November invariably dispersed and climbed on the plants immediately after moulting.

Dormant ticks spent the dry months in a state of repose with the legs folded and clinging to the undersurface of the litter leaves. When the leaves were turned upside down and exposed to light they became active within 1 to 3 minutes, crawled toward the undersurface and again came to rest. Under direct sunlight activation was immediate and the ticks immediately rushed towards darker places.

Onset of activity of dormant adults:

Invariably the dormant ticks became active after the first few monsoon rains. Ticks lying under thick forest canopy became active a few days earlier than those lying under thin canopy or under direct sunlight. Gradually they emerged from the litter and settled on the undergrowth vegetation. Total displacement was observed 10 to 40 days after the onset of activity. Initially ticks were found on plants of all heights upto 150 cm, but later the ticks settled on smaller plants (2 to 15 cm) descended, spread out and settled on larger plants.

The dormant adults of group nos. 2 and 27 were sprayed with water. From group No. 2, seven ticks emerged to the surface of litter after spraying twice a day for 3 days. The spraying was continued for 3 more days but none of the ticks climbed on plants. When the spraying was stopped ticks withdrew into litter. The group no. 27 was sprayed twice a day from 10 to 15 March 1965. On 11 March several ticks emerged on the litter surface and the same evening 4 ticks were recovered from plants. On 13 March, 7 more were collected from plants. On the same evening the atmospheric humidity of the niche was increased by enclosing the plants with wet absorbent lint flags suspended on wooden frame. As a result 27 ticks were collected from plants on 15 March. The operation was concluded on 15th and the active ticks on the litter withdrew to the litter. They resumed their dispersal activity only after a few heavy rains in June.

Recovery of adults:

The largest number of ticks recovered from each group is presented in table 5, which

varied from batch to batch depending upon the ecological conditions of the place of release.

Survival of adults:

Ticks from nymphal groups 4, 6, 8, 18 and 19, which emerged from the litter in June 1964, reached their maximum number in the middle of July and gradually decreased afterwards until January 1965. The last tick of the group 4 disappeared during the last week of December 1964. The last ticks of groups 6, 8, 18 and 19 disappeared during the last week of January, last week of March, first week of February and the last week of January 1964, respectively.

Discussion

General remarks:

Behaviour during the three stages of the tick *H. spinigera* in its natural habitats is of special importance for understanding the epidemiology of KFD. The disease is now known to have a complex natural history and is known to directly involve two species of monkeys-*Presbytis entellus* and *Macaca radiata*, several species of small mammals, particularly two species of rats — *Rattus rattus wroughtoni* and *Rattus blanfordi*, one species of shrew — *Suncus murinus*, and about 15 species of ticks. Several species of birds and a few species of bats are suspected to be involved. Several other species of mammal are indirectly involved as they act as hosts to the ticks and influence the magnitude of tick population. It is now known that the principae vector is *H. spinigera* (Boshell 1969).

Much of the information available so far was gathered indirectly as a result of collections made for various purposes. It will be useful to review briefly the available knowledge on the life history of the species. *H. spinigera* is a three-host tick with a long free living phase and a brief parasitic phase in each stage of its life cycle. In each stage, the behaviour of unfed and fed individuals differs fundamentally. Unfed individuals are active and their movements are directed towards finding a suitable host. Fed individuals are less active and their movements are directed toward a shelter for moulting or egg laying as the case may be. Orientation mechanisms and behaviour patterns have evolved according to the appropriate needs.

The adults are abundant in the forests of study area during the rainy seasons from June to September. A few individuals survive through dry months. The first broods of larvae appear on vegetation a few days after the cessation of the monsoon and their population predominates during October and November, but some larvae persist throughout the dry weather. Nymphs appear on vegetation in November, but in greatest number in January and February and decline gradually afterwards. A few nymphs persist throughout the monsoon. The present study reveals some aspects of the intimate life habits and behaviour of *H. spinigera.*

Prevalence and activity:

It has become a general practice among ecologists and epidemiologists to determine the season of prevalence of ticks by the numbers collected either by flag dragging or searching host animals for ectoparasites. The number thus collected best reflects the number of ticks in the questing phase. In the present study, it has been shown that for long period of time, ticks in different stages may be dormant in the litter. In such cases ticks may be "prevalent" but not active. This consideration has been generally ignored and the seasons of prevalence have generally been equated with

the seasons of activity. The present study elucidates the difference between the "prevalence" indicating the presence of the tick stage in the environment whether active or inactive, and "activity" which indicates only the presence of ticks in their questing phase.

Life cycle :

The life cycle of individual *H. spinigera*, under forest environment in KFD area takes about one year, each stage being active in a particular season, *viz.* — Adult: June to September, Larva: September to November, Nymph: November to June. The seasonal limits are not necessarily precise and a few individuals of one stage overlap with the other stages. In temperate countries the life activities of ticks come practically to a standstill during winter months and in general, all stages are active during the warm season. Hence the life cycles of the ticks generally take two to four years to complete. On the other hand, in tropical conditions, as in KFD area, there is no season that is hostile to tick activity and the life cycle is completed in a continuous sequence. Under field conditions, the shortest estimated period for the completion of on life cycle was 101 days and the longest was 935 days, although these are extremes in the range of possible variations. The association of the activity of each stage with each season has provided basic problems of the ecology of *H. spinigera*.

Under field conditions the temperature range to which developing and dormant stages were exposed was between 17.5°C and 25°C, well within the favourable range observed in the laboratory (Bhat 1979). The life cycle appears to be well adapted to its rigid humidity requirements. .Adult activity coincides with the wet monsoon months, which provides necessary high humidity for delicate developing eggs and larvae. The exodus of larvae from the litter commences with the end of the monsoon and their activity coincides with the humid post monsoon months of October and November. The period of nymphal activity is very prolonged extending from November to June. Though there is a gradual reduction in atmospheric humidity, the litter remains moist until the end of March. These conditions permit sustenance of active nymphs. Adults emerging from nymphs undergo dormancy under the litter and escape the dry climate of April and May.

Seasonal activity :

Prevalence of adults on the vegetation on the onset of monsoon is a result of activation of cumulative adult population dormant under the litter. Initiation of activity is followed by a gradual dispersal along the ground, and climbing and settling on the vegetation. About 4 weeks after their first appearance on the vegetation the population reaches its maximum level. From August onwards the population decreases gradually till November. From December to May a small number of stray adults persist. Prevalence of questing larvae which coincides with the cessation of rain is also the result of the exodus of dormant larvae accumulated during monsoon months. The appearance of questing nymphs follows the larval activity. A similar pattern of incidences of larvae nymphs and adults on their avian and mammalian hosts have been observed (Rajagopalan 1972, Rajagopalan *et al.* 1968 a and b).

It is obvious that dormancy of the adults during dry months and the larvae during monsoon months determine the seasonal activity of different stages. Adult activity is inhibited by dryness and the larval activity by moisture. The two phases of adult and larval inactivity

in the seasonal cycle occur under two climatic conditions. The activation of adults after spraying water on the litter indicates that the humidity is the chief factor determining the dormancy of adults.

KFD epidemics and epizootics in relation to bionomics of *H. spinigera*:

The above information may explain some of the epidemiological problems of KFD. The monkey mortality due to epizootics and epidemics occur in drier months of the year from December to June, with a peak in February and March (Boshell 1968). Both epizootics and epidemics coincide with the nymphal prevalence and activity. Survival of the nymphs through the rainy season suggests the carry over of the virus by the infected nymphs through the rainy season enabling the start of a new virus cycle in the following season (Rajagopalan and Anderson 1970).

The extremely long life span of each stage provides greater chance for the virus to survive in its tick host until its next encounter with a vertebrate host. Viral persistence in ticks (Varma *et al.* 1960) suggests that the virus can be held in an inapparent state by infected ticks, a significant aspect of their role as reservoir of vertebrate infection.

Acknowledgements

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FRESHWATER ALGAE OF SHILLONG, MEGHALAYA (INDIA)[1]

G. R. HEGDE[2]

(With three plates)

A total of 45 fresh water algal taxa, collected from a pond in Shillong, Meghalaya has been reported. These include 2 from Cyanophyta, 16 from Chlorophyta, 9 from Euglenophyta, 2 from Pyrrhophyta and 16 from Chrysophyta.

The present work is the study of a freshwater sample collected from a pond in Shillong during September 1983. Shillong, the capital city of Meghalaya is situated between 25° 34′ N latitude and 91° 53′ E longitude. The annual average rainfall is 208 cms. During winter shallow water freezes at night but snow seldom falls and during hottest weather temperature rarely rises above 28°C. The sample was preserved in 4 per cent formaldehyde solution and deposited in Algal Laboratory, Karnatak University, Dharwad.

In the text the abbreviations used are:

L = Length; W = Width; I = Isthmus;
D = Diameter.

CYANOPHYTA

Chroococcus limneticus Lemm. var. **elegans** G. M. Smith (Pl. 1, Fig. 1).
Prescott 1951; Pl. 100, fig. 11, p. 448.
L cell 24-26 μm; W cell 18-20 μm.

Oscillatoria chalybea Mertens (Pl. 1; Fig. 2).
Prescott 1951; Pl. 109, figs. 8 and 9, p. 486.
L cell 4-6 μm; W cell 6-7 μm.

CHLOROPHYTA

Spaerocystis schroeteri Chodat (Pl. 1; Fig. 6).
Prescott 1951; Pl. 3; fig. 6, p. 83.
D cell 18-20 μm.

Pediastrum tetras (Ehr.) Ralfs var. **tetraodon** Corda) Rabenh. (Pl. 1; Fig. 3).
Philipose 1967; fig. 45d; p. 130.
L marginal cell 11 μm; W marginal cell 10-12 μm.

Scenedesmus abundans (Kirchner) Chodat var. **brevicauda** G. M. Smith (Pl. 1; Fig. 4).
Philipose 1967; fig. 184d, p. 279.
L cell 13-14 μm; W cell 5-6 μm; L spines 4-5 μm.

The plant resembles the type described in shape and ornamentation of spine, but differs in having longer spines (Type L spines 1.3-3 μm).

S. dimorphus (Turp.) Kütz. (Pl. 1; Fig. 5)
Philipose 1967; fig. 160c, p. 249.
L cell 24-26 μm; W cell 3-4 μm.

The plant differs from the type described in having less curved terminal cell. Unlike the type the terminal cells have the apices recurved on the inner side.

S. dimorphus (Turp.) Kütz. (Pl. 1; Fig. 7).
Philipose 1967; fig. 160a, p. 249.
L cell 30-31 μm; W cell 6-8 μm.

Differs from the type in the shape of outer lunate cells which have convex bulging on their outer walls.

Some specimens in this collection exhibit a varied shape — colony is curved with individual cells having longer spines which are curved on the inner side (Pl. 1; Fig. 9).

[1] Accepted January 1984.
[2] Algal Laboratory, P. G. Department of Botany, Karnataka University, Dharwad-580 003.

S. quadricauda (Turp.) Bréb. var. **bicaudatus** Hansgirg (Pl. 1; Fig. 8).

Philipose 1967; fig. 187, k; p. 234.

L cell 9-10 μm; W cell 5 μm; L spines 4-6 μm.

Differs from the type described in having 2-3 smaller spines at the poles of inner cells. In this character the plant is more closer to *S. longus* Meyen (Prescott 1951; pl. 63, fig. 16, p. 278).

Netrium digitus (Ehr.) Itzigs. et Rothe (Pl. 1, Fig. 13).

Iyengar et Vimala Bai 1941; figs. 5 and 6, p. 74.

L138 μm; W middle 33-35 μm; W pole 13-15 μm.

Slightly smaller than the type described. Type L 155-203 μm; W 40-44 μm; apex 18-23 μm.

N. digitus var. **lamellosum** (Bréb.) Grönblad (Pl. 1; Fig. 14).

Scott et Prescott 1961; Pl. 1, fig. 6, p. 8.

L 180-183 μm; W middle 34-36 μm; W apex 15-17 μm.

Smaller than the variety *lamellosum* (Bréb.) Grönblad of *N. digitus* (Ehr.) Itzigs et Rothe described by Scott et Prescott 1961 (L 336 μm; W 57 μm). However, size is similar to formae *minores* of variety *lamellosum* (Bréb.) Grönblad described by Förster 1972; Pl. 1, figs. 5 and 6, p. 522.

Closterium dianae Ehr. var. **pseudodianae** (Roy) Krieg. (Pl. 1, fig. 10).

Hinode 1971; Pl. 2, figs. 3 & 4, p. 103.

L 289 μm; W 23-25 μm.

C. navicula (Bréb.) Lütkem. (Pl. 1; Fig. 15).

Rino 1971; Pl. 1, Fig. 10, p. 17.

L 106-108 μm; W middle 36-37 μm; W pole 12-13 μm.

Present plant is more broader than type. Type W 22 μm.

Pleurotaenium trabecula (Ehr.) Näg. (Pl. 2; Fig. 16).

Iyengar et Vimala Bai 1941; figs. 20 and 21, p. 79.

L 457-460 μm; W 30-32 μm; I 23-24 μm.

Cosmarium globosum Bulnh. (Pl. 1; Fig. 11).

Hinode 1971; Pl. 6, fig. 8, p. 115.

L 33-35 μm; W 18-20 μm; I 17-18 μm.

C. lundellii Delp. var. **circulare** (Riensch) Krieg. (Pl. 2; Fig. 17).

Scott et Prescott 1961; pl. 25, fig. 7, p. 60.

L 48-50 μm; W 41-43 μm; I 14-15 μm.

Comparatively smaller than the type described.

Type L 71 μm; W 58 μm; I 25 μm.

C. regnellii Wille (Pl. 1; Fig. 12).

Scott et Prescott 1961; Pl. 23, Fig. 12, p. 68.

L 10-11 μm; W 8-9 μm; I 2-3 μm.

The present plant is much smaller than the type.

Type L 22 μm; W 19 μm; I 6 μm.

Actinotaenium australe (Racib.) var. **minor** Hodgetts (Pl. 2; Fig. 18).

Bourrelly 1975; Pl. 8, fig. 5, p. 32.

L 39-40 μm; W 21-23 μm; I 20-21 μm.

Hyalotheca dissiliens (Smith) Bréb. var. **hians** Wolle (Pl. 2; Fig. 19).

Scott et Prescott 1961; Pl. 61, fig. 2, p. 122.

L 18-19 μm; W 26-27 μm; I 25-26 μm.

Width of the plant is comparatively more than the type.

Type W maximum 15 μm.

EUGLENOPHYTA

Euglena polymorpha Dang. (Pl. 2; Fig. 21).

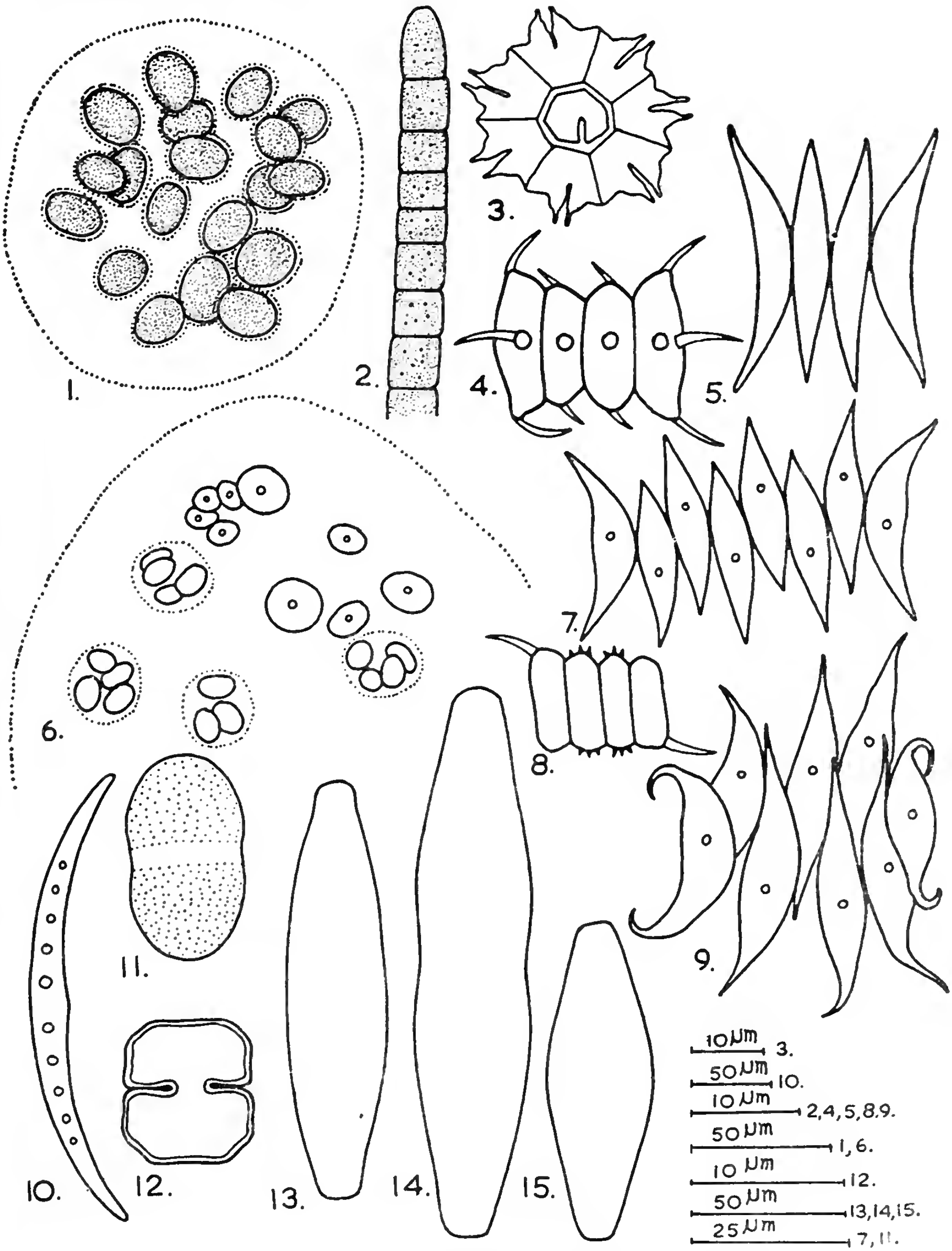
Prescott 1951; Pl. 85, figs. 21 and 22: p. 393.

L 77-80 μm; W 20-22 μm.

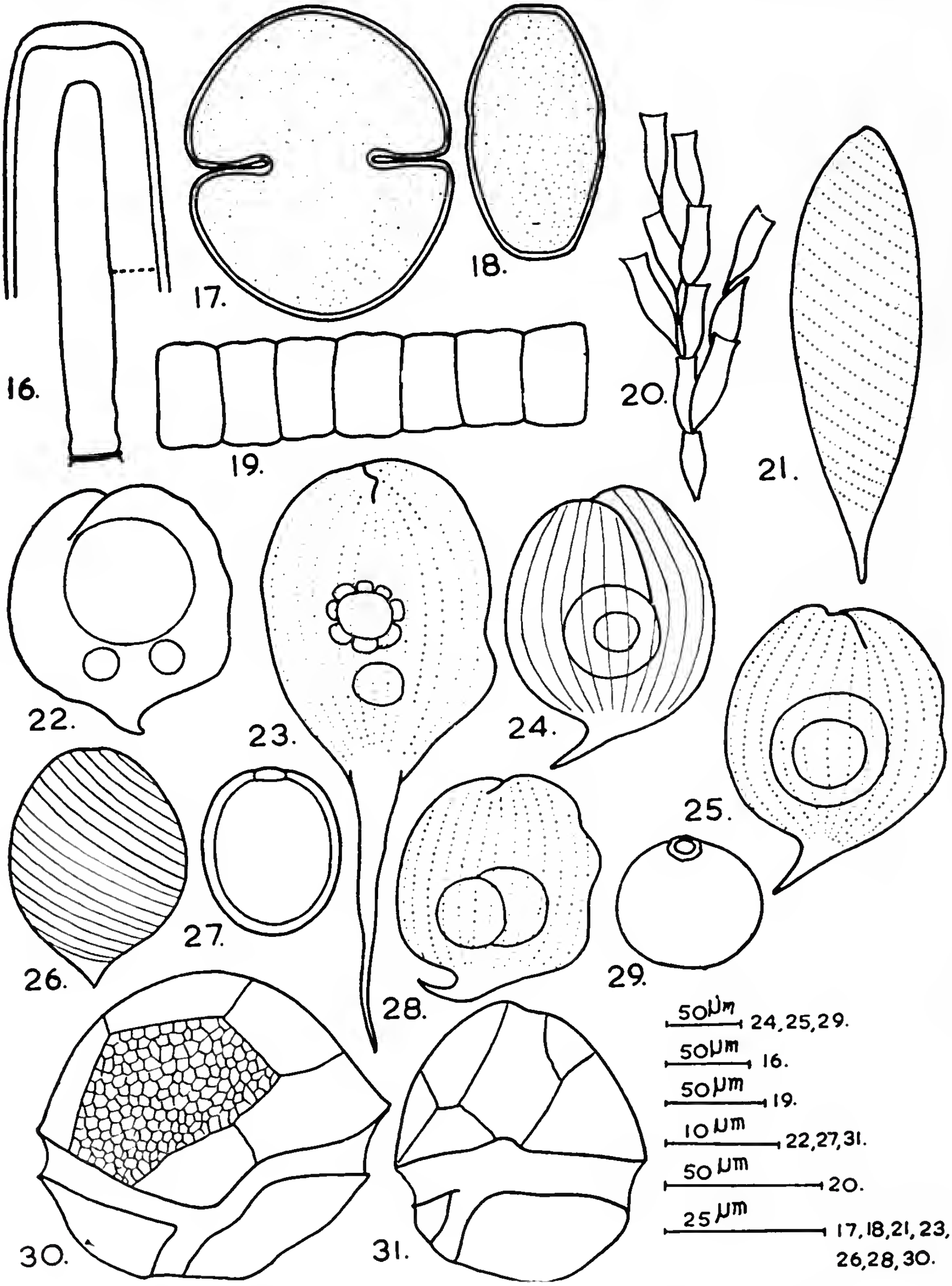
Phacus curvicauda Swir. (Pl. 2; Fig. 22).

Prescott 1951; Pl. 87, fig. 14, p. 399.

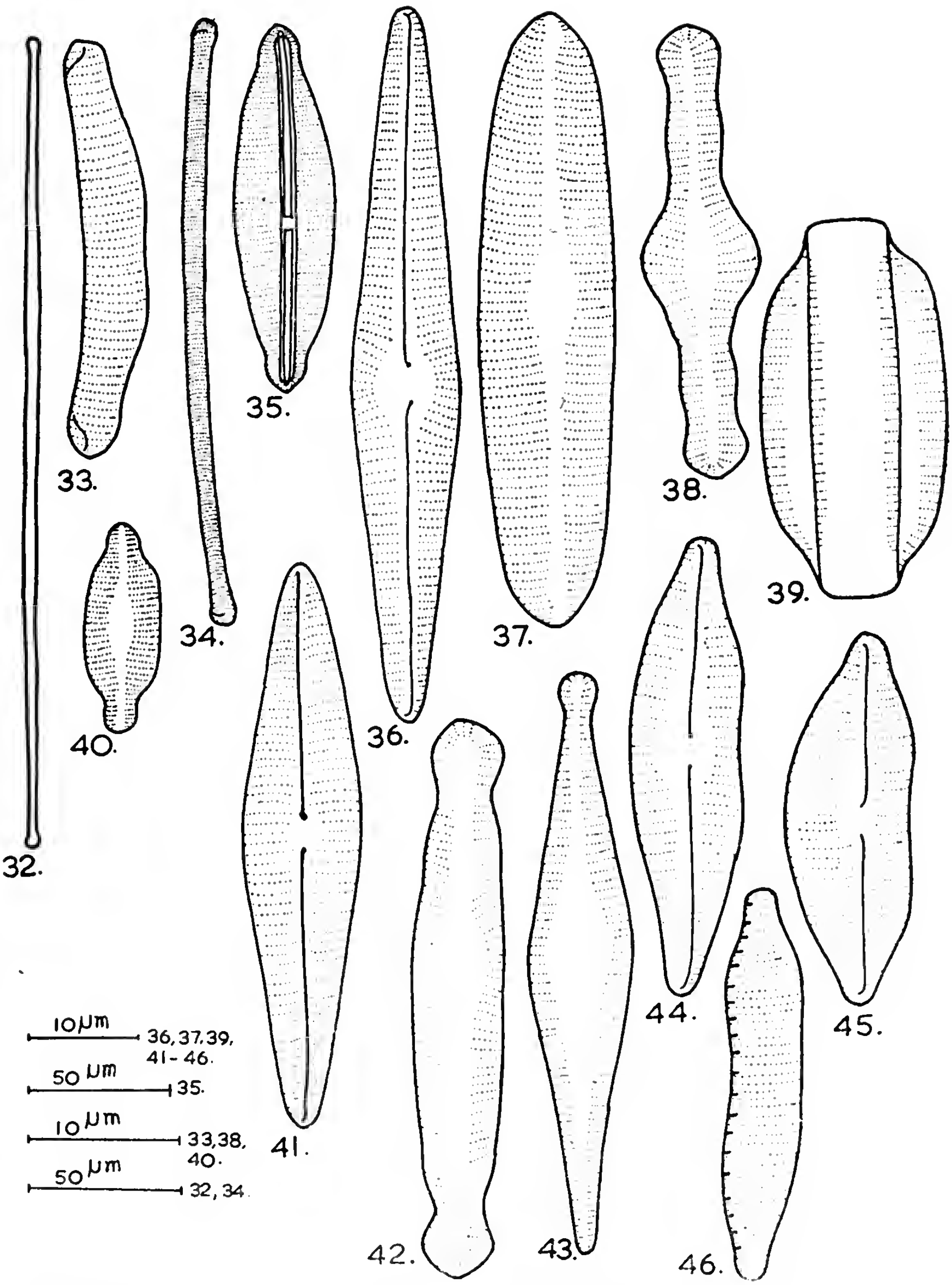
L 20-22 μm; W 19-20 μm.



1. *Chroococcus limneticus* Lemm. var. *elegans* G. M. Smith; 2. *Oscillatoria chalybea* Mertens; 3. *Pediastrum tetras* (Ehr.) Rals var. *tetraodon* (Corda) Rabenh.; 4. *Scenedesmus abundans* (Kirchner) Chodat var. *brevicauda* G. M. Smith; 5, 7 & 9. *S. dimorphus* (Turp.) Kütz.; 6. *Sphaerocystis schroeteri* Chodat; 8. *Scenedesmus quadricauda* (Turp.) Bréb. var. *bicaudatus* Hansgirg; 10. *Closterium dianae* Ehr. var. *pseudodianae* (Roy) Krieg.; 11. *Cosmarium globosum* Bulnh.; 12. *C. regnellii* Wille; 13. *Netrium digitus* (Ehr.) Itzigs *et* Rothe; 14. *N. digitus* var. *lamellosum* (Bréb) Gronblad; 15. *Closterium navicula* (Bréb.) Lutkem.



16. *Pleurotaenium trabecula* (Ehr.) Näg.; 17. *Cosmarium lundellii* Delp. var. *circulare* (Reinsch) Krieg.; 18. *Actinotaenium australe* (Racib) var. *minor* Hodgetts; 19. *Hyalotheca dissiliens* (Smith) Bréb. var. *bians* Wolle; 20. *Dinobryon sociale* Ehr.; 21. *Euglena polymorpha* Dang.; 22. *Phacus curvicauda* Swir.; 23. *P. longicauda* (Ehr.) Dujardin; 24. *P. pleuronectes* (O.P.M.) Dujardin; 25. *P. orbicularis* Hubner; 26. *Lepocinclis ovum* (Ehr.) Lemm.; 27. *Trachelomonas dybowskii* Drez.; 28. *Phacus onyx* Pochmann; 29. *Trachelomonas volvocina* Ehr. var. *compressa* Drez.; 30. *Peridinium cinctum* (Müll.) Ehr.; 31. *P. umbonatum* Stein.



32. *Synedra ulna* (Nitz.) Ehr. var. *danica* (Kütz.) Grun.; 33. *Eunotia tschirchiana* Mull.; 34. *E. valida* Hust.; 35. *Frustulia rhomboides* (Ehr.) De Toni var. *saxonica* (Rab.) De Toni; 36. *Navicula radiosa* Kütz. var. *tenella* (Bréb.) Grun.; 37. *Pinnularia brebissonii* (Kütz.) Cleve; 38. *Tabellaria flocculosa* Kütz.; 39. *Amphora coffeaeformis* Agardh; 40. *Achnanthes exigua* Grun.; 41. *Gomphonema gracile* Ehr.; 42. *Pinnularia braunii* (Grun.) Cleve var. *amphicephala* (Mayer) Hust.; 43. *Gomphonema subtile* Ehr. var. *malayensis* Hust.; 44. *Cymbella tumida* (Bréb) V. H.; 45. *C. excisa* (Kütz.) De Toni; 46. *Hantzschia amphioxys* (Ehr.) Grun. var. *pusilla* Dippel.

P. longicauda (Ehr.) Dujardin (Pl. 2; Fig. 23).
Prescott 1951; pl. 87, fig. 1, p. 400.
L 50-51 μm; W 36-38 μm; L caudus 45-47 μm.
P. onyx Pochmann (Pl. 2, Fig. 28).
Suxena 1955; figs. 51 and 52; p. 440.
L 31-32 μm; W 31-32 μm; L caudus 10-12 μm.
P. orbicularis Hubner (Pl. 2, Fig. 25).
Suxena 1955; fig. 24, p. 439.
L 33-34 μm; W 30-32 μm; L caudus 9-10 μm.
P. pleuronectes (O.F.M.) Dujardin (Pl. 2; Fig. 24).
Suxena 1955; fig. 22, p. 440.
L 34-36 μm; W 28-30 μm; L caudus 9-11 μm.
Lepocinclis ovum (Ehr.) Lemm. (Pl. 2, Fig. 26).
Prescott 1951; pl. 89, figs. 5 and 6, p. 407.
L 37-39 μm; W 28-30 μm.
Bigger than the type described. Type L 28-30 μm; W 22-25 μm.
Trachelomonas dybowskii Drez. (Pl. 2, Fig. 27).
Prescott 1951; pl. 83, fig. 21, p. 412.
L 15 μm; W 12-14 μm.
T. volvocina Ehr. var. **compressa** Drez. (Pl. 2. Fig. 29).
Prescott 1951; Pl. 83, figs. 2 and 3; P. 419).
D 18-21 μm.

PYRRHOPHYTA

Peridinium cinctum (Müll) Ehr. (Pl. 2; Fig. 30).
Prescott 1951; pl. 91, figs. 1-4; p. 432.
L 47-49 μm; W 52-56 μm.
P. umbonatum Stein (Pl. 2; Fig. 31).
Yacubson 1974; Pl. 7, fig. 74, p. 122.
L. 25-26 μm; W 22-23 μm.

CHRYSOPHYTA

Dinobryon sociale Ehr. (Pl. 2, Fig. 20).
Nygaard 1976; Pl. 2, fig. 14, p. 23.
L 26-28 μm; W 9-10 μm.
Synedra ulna (Nitz.) Ehr. var. **danica** (Kütz) Grun. (Pl. 3, fig. 32).
Gandhi 1955; fig. 6, p. 311.
L 263-273 μm; W 5-6 μm.
Eunotia tschirchiana Müll. (Pl. 3, Fig. 33).
Gandhi 1960; fig. 1, p. 559.
L 27-30 μm; W 4-5 μm. Striae 12-14 in 10 μm.
E. valida Hust. (Pl. 3, Fig. 34)
Hirano 1969; Pl. 4, fig. 1, p. 17.
L 197-200 μm; W 6-8 μm. Striae 10-12 in 10 μm.
Differs from the type in having more length. Type L 110-167 μm.
Achnanthes exigua Grun. (Pl. 3, Fig. 40).
Gonzalves and Gandhi 1952; fig. 49a, b, p. 143.
L 13-15 μm; W 5-6 μm. Striae 20-22 in 10 μm.
Frustulia rhomboides (Ehr.) De Toni var. **saxonica** (Rab.) De Toni (Pl. 3. Fig. 35).
Krishnamurthy 1954; fig. 27, p. 362.
L 57-60 μm; W 16-18 μm. Striae 20-24 in 10 μm.
Navicula radiosa Kütz. var. **tenella** (Bréb.) Grun. (Pl. 3, Fig. 36).
Gandhi 1955; fig. 21, p. 321.
L 65 μm, W 9-10 μm. Striae 15-20 in 10 μm.
Differs from the type in having bigger size. Type L 45-50 μm; W 8-8.7 μm.
Pinnularia braunnii (Grun.) Cleve var. **amphicephala** (Mayer) Hust. (Pl. 3; Fig. 42).
Sarode and Kamat 1983, fig. 1, p. 26.
L 50-52 μm; W middle 7-8 μm. Striae 10-14 in 10 μm.
P. brebissonii (Kütz.) Cleve (Pl. 3; Fig. 37).
Gandhi 1960; Pl. 1, fig. 25; p. 89.
L 55 μm; W 12-14 μm. Striae 10-12 in 10 μm.
Tabellaria flocculosa Kütz. (Pl. 3, Fig. 38).
Nygaard 1976; Pl. 1, fig. 29, p. 26.
L 44 μm; W middle 7-8 μm; W pole 4-5 μm. Striae 9-10 in 10 μm.
Amphora coffeaeformis Agardh (Pl. 3; Fig. 39).
Majeed 1935; Pl. 4, Fig. 9, p. 26.
L 33-35 μm; W 16-18 μm.

Symbella excisa (Kütz.) De Toni (Pl. 3, Fig. 45).
Majeed 1935; Pl. 4, fig. 2, p. 28.
L 33-35 μm; W 11-13 μm. Striae 15-20 in 10 μm.

C. tumida (Bréb.) V. H. (Pl. 3; Fig. 44).
Agarkar 1976; Pl. 7, fig. 10, p. 71.
L 65-68 μm; W 10-12 μm. Striae 10-12 in 10 μm.

Gomphonema gracile Ehr. (Pl. 3; Fig. 41)
Krishnamurthy 1954; fig. 53; P. 374.
L 50-55 μm; W 10-12 μm. Striae 12-16 in 10 μm.

G. subtile Ehr. var. **malayensis** Hust. (Pl. 3; Fig. 43).
Gandhi 1960; Pl. 3, fig. 82, P. 109.
L 52-55 μm; W 9-11 μm; W pole 3.5-4 μm. Striae 10-12 in 10 μm.

Hantzschia amphioxys (Ehr.) Grun. var. **pusilla** Dippel (Pl. 3; Fig. 46).
Gandhi 1956; fig. 6, p. 406.
L 35-38 μm; W 17-18 μm; W pole 6-7 μm. Striae 14-16 in 10 μm.

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COMMENTARY ON A PICTORIAL GUIDE TO THE BIRDS OF THE INDIAN SUB-CONTINENT[1]

TOM ROBERTS[2], RICHARD GRIMMETT[3] AND CRAIG ROBSON[4]

The publication of this field guide by the Bombay Natural History Society, as part of their activities to celebrate the occasion of the Society's Centenary, was a remarkable achievement. Not only because a total of 1241 species have been illustrated, often with both male and female plumages, and in some cases flight patterns and immature or non-breeding plumages as well, but because it is, withal, a relatively slim portable volume and very inexpensive by modern day standards. Its low price reflects well one of the principal aims of the Society, which is to enable the widest possible cross-section of people to develop an interest in studying and appreciating the natural history of the sub-continent. The low cost is due largely to the generous donation of plates by the original sponsoring authorities, the U.S. Fish and Wildlife Service and the Smithsonian Institution, as well as the support and encouragement of the American Museum of Natural History which helped the original project by providing the specimens from which the artist was able to paint the plates. The comprehensive coverage of the illustrations is largely due to the painstaking efforts of Ben King in selecting suitable specimens, backed up by his unrivalled knowledge of the region. That the general proportions, attitudes and colours of the plates are remarkably close to appearances of these birds in the wild (with one or two exceptions, such as the position of outer toes in the Owls), speaks volumes for the acute observations and great accuracy of the artist John Henry Dick, and the authors of this note stress that this last tribute is more than the polite commendations of a reviewer, based as it is, upon our own several experiences in illustrating bird books.

In our view the Pictorial Guide deserves to be the main standby for field ornithologists in the region for many years to come. There are, however, some notable omissions and errors in this book, which we believe have resulted largely from the pressure of the publications deadline, with respect to the September 1983 Centenary Celebrations. We feel that it is important to draw attention to those errors which we have noticed, with the dual aim of enhancing the value of the book and of enabling field workers to give due consideration to potential identification problems.

Omission of Species

There are several criteria against which the Pictorial Guide can be judged. If the complete list of species described in the Handbook Series (Ali and Ripley 1968-74), and the Revised Synopsis (Ripley 1982) are considered, then over 30 full species covered by these two publications are omitted. All but nine of

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these are either vagrants or are only marginally recorded in the sub-continent, and their inclusion would not greatly enhance the very comprehensive coverage of the Pictorial Guide. Paradoxically, out of 1241 species illustrated, 22 are included which are extra-limital and have not been recorded in the sub-continent as yet, though presumably there is a possibility since they do occur in adjacent regions. As noted above, nine of the species omitted are resident or regular visitors to the Indian sub-continent and they are included in the Handbook series (op. cit. 1968-74). A commentary on these follows:

1) Red Breasted Merganser (*Mergus serrator*). A Rare but regular winter visitor along the Karachi and Makran coast.

2) Red-necked or Eastern Little Stint (*Calidris ruficollis*). Recent wader surveys along the eastern sea-board of India have resulted in a number of reliable sightings. The first records for Pakistan were obtained recently as well, with 2 on July 20th 1984 (R. Passburg and N. Van Zalinge), and 3 on August 14th, and 18th, in the same year (N. Van Zalinge). These were all birds still in breeding dress and seen and photographed in company with *Calidris alpina* and *Calidris minuta* on inland waters close to the Karachi seacoast (to be published).

3) Saunder's Tern (*Sterna saundersi*). Treated as a separate species from *Sterna albifrons* in the Revised SYNOPSIS (1982), on the basis of its recorded sympatric breeding in Sri Lanka, plus different wing-tip pattern, bill and leg colour and call. It is not uncommon breeder along the Karachi coast and in Kutch.

4) Oriental or Himalayan Cuckoo (*Cuculus saturatus*). Quite a common breeding bird right across the Himalayas.

5) Brown-crowned Pigmy Woodpecker (*Dendrocopos* (*Picoides*) *nanus*). There could be some taxonomic confusion here. Only *Dendrocopos* (*Picoides*) *moluccensis* is illustrated (Plate 61) and treated as extra-limital. The modern tendency is to treat *nanus* as a subspecies of *P. moluccensis* (Howard and Moore 1980, Short 1982). Examination by us, of a series of skins of *P. nanus* and *P. moluccensis* held in the British Museum (Tring), revealed that they would be separable in the field quite readily, with a different throat pattern (white in *moluccensis*), streaked grey in *nanus*) and a different prominence of moustachial streak, (strongly marked in *moluccensis*, rather obsolete in *nanus*), as well as different nape pattern. (black in *moluccensis* more extensively brown in *nanus*). *P. nanus* occurs quite extensively in Sri Lanka and in southern and north-western India. The bird illustrated in Plate 61 corresponds with *P. nanus*, and should have been listed as *P. nanus* or *P. moluccensis nanus* (following Short, op. cit.).

6) Hume's Short-toed Lark (*Calandrella acutirostris*). This lark breeds widely in Baluchistan at medium altitudes (T.J.R.) as well as in Ladakh (Ali & Ripley, op. cit.), and is a summer visitor to the trans-Himalayan districts of Nepal (Mustang and Dol Po).

7) Blyth's Pipit (*Anthus godlewskii*). This pipit is a widespread winter visitor to north eastern and peninsular India (Ali & Ripley 1973). It looks very similar to *A. novaeseelandiae* in the field.

8) Blunt-winged Paddyfield Warbler (*Acrocephalus concinens*). A breeding species in both Kashmir, Hazara district of Pakistan, and Assam. It can be separated from *A. agricola* by its wing formula (see Ali & Ripley, Vol. 8), and with difficulty in the field, by its slightly longer bill, less prominent supercilium and less rufous plumage compared to *agricola*.

9) Eastern Great Reed Warbler (*Acroce-

phalus orientalis). This is treated as a separate species by Ali and Ripley in the HANDBOOK (op. cit., Vol. 8, 1973) and by Ripley in the SYNOPSIS (1982). Most European authorities treat it as a sub-species of *Acrocephalus arundinaceus* (Williamson 1963, Voous 1977). It is apparently a regular winter visitor to north-east India and the Andaman Islands.

The treatment of Andaman and Nicobar Islands' birds has not been comprehensive. Thus the Narcondam Hornbill (*Rhyticeros* (*plicatus*) *narcondami*) is included, whereas the Andaman Brown Hawk Owl (*Ninox affinis*) is not. Similarly, the treatment of vagrants to the Indian sub-continent has not been consistent. Thus illustrations of some have been included where there has been one or two, not very recent, authentic records, e.g. Pallas's Sandgrouse (*Syrrhaptes paradoxus*), Red-throated Diver (*Gavia stellata*) and Red-breasted Goose (*Branta ruficollis*). Others, though included in the HANDBOOK, have not been illustrated, e.g. Grey Phalarope (*Phalaropus fulicarius*), Spotted Greenshank (*Tringa guttifer*) and Snowy Owl (*Nyctea scandiaca*), also the Eurasian Great Reed Warbler (*Acrocephalus arundinaceus*). Though the inclusion of the Eurasian Great Reed Warbler in the HANDBOOK series (op. cit.) rests upon a single specimen collected from Kalat, Baluchistan by Zugmayer on October 4th 1911, its similarity to *A. stentoreus* and possibility of thus being overlooked, warrants its inclusion.

There are also several species reliably recorded in the Indian sub-continent in recent years which are also not included in the Pictorial Guide, and we comment here on two species that have been recorded several times in recent years .

1) Common Gull (*Larus canus*). F. Koning during IWRB surveys in Pakistan in the early 1970's obtained 2 reliable sightings: one on Rasul Barrage headpond in the Punjab and one on Khinjir Lake in lower Sind. It has also more recently been recorded near Delhi and in eastern Nepal in 1979 (Redman *et al.* 1984). It was again seen in Pakistan on Khinjir Lake on 4th April 1984 (by R. G. & C. R.). This species is not listed in the HANDBOOK or SYNOPSIS.

2) Song Thrush (*Turdus philomelos*). Not included in the HANDBOOK or SYNOPSIS, this thrush has been reliably sighted several times in recent years. One in Ladakh in 1980, one at Bharatpur, Rajasthan by S. Whitehouse and M. J. Parr in 1981, and most recently at Las Bela, Pakistan in early March 1984 (by T.J.R., R. Passburg & D. Corfield, to be published).

Omission of Sub-species

Again there are several criteria against which the omission of sub-species might be judged. Bearing in mind limitations of publication costs, the Pictorial Guide has tried to include a number of distinctive sub-species, but there are several decisions or omissions, which we would like to comment upon, in the light of recent taxonomic thinking.

1) Oriental or Indian Scops Owl (*Otus sunia*). In the HANDBOOK series this is treated as a sub-species of *O. scops*, which is illustrated in the Pictorial Guide without any reference to sub-species. Recent authors have treated *sunia* as a separate species (Gallagher and Woodcock 1980, Voous 1977). There is clear ecological allopatry between *sunia* and *O. scops pulchellus* or *O. scops turanicus* which occur in the sub-continent, and also these two owls (*sunia* and *scops*) have very distinctive stereotyped territorial calls (Roberts and King, in press), and they are clearly recognisable in certain circumstances.

2) Bright Green Leaf Warbler (*Phylloscopus nitidus*). Treated as a sub-species of *P.*

trochiloides in the HANDBOOK and not illustrated in the Pictorial Guide though separable with difficulty in the field and treated as a distinct species by recent authors (Williamson 1974, Voous 1977).

3) Mountain Chiffchaff (*Phylloscopus sindianus*). Treated as a sub-species of *P. collybita* in the Handbook and not illustrated though considered a distinct species by recent authors (Williamson 1974, Voous 1977). It is also noteworthy that Edwin Brooks considered that they were distinctive and separable even on their wintering grounds (Brooks 1879).

4) White-browed Blue Flycatcher (*Muscicapa superciliaris*). In a different category, the treatment of this species is noteworthy. Plate 92 covering flycatchers includes figures of 2 distinct subspecies, viz: *M. parva albicilla* and *M. leucomelanura minuta*, but only the Western Himalayan form of the White-browed Blue Flycatcher. From extreme eastern Nepal and through Assam an eastern sub-species *M. superciliaris aestigma* occurs, which entirely lacks any white eyebrow. In view of the confusing trivial name, it would have been helpful to include an illustration of this feature.

The name Ultramarine Flycatcher applied to the South East Asian population (see King *et al.* 1975), would seem a desirable change.

Presumed Printers or Illustrator's Errors

1) Indian Plaintive Cuckoo (*Cacomantis passerinus*). Some taxonomic and geographic confusion could arise here, as Voous (1973) treats the Indian Plaintive Cuckoo as *C. merulinus*. However, other authors have either split the grey-bellied form into a separate species *Cacomantis passerinus* (King *et al.* 1975), or as a sub-species *C. merulinus passerinus* (Ali & Ripley 1969). The distribution given for *C. passerinus* is incorrect, incidentally, stating that it is absent in Pakistan, whereas it is a regular summer visitor in the sub-Himalayan foothill zone (T.J.R.).

2) On Plate 58, the two Stork-billed Kingfishers have been transposed, both in the plate and accompanying captions. Thus Fig. 9 should be Stork-billed Kingfisher, *Pelargopsis capensis* and 12 should be the Brown-winged Kingfisher, *Pelargopsis amauroptera*.

3) Slaty-headed Scimitar Babbler (*Pomatorhinus horsfieldii*). On plate 74 there appears to be a confusing error both in distributional range and nomenclature here. Fig. 18 with rusty-orange flanks is the form which occurs in the north-eastern Himalayas and north-eastern hill states, and Fig. 19, which should show slaty black or dark-grey flanks, is the form which occurs in southern peninsular India: the two distributional ranges have therefore been transposed. In the Pictorial Guide the nomenclature follows that of the Revised SYNOPSIS (Ripley 1982) and they are correctly, but confusingly, named *P. horsfieldii schisticeps* and *P. horsfieldii*, the latter representing the nominate sub-species which was originally described from Travencore (South India). Unfortunately in the HANDBOOK (Ali & Ripley, Vol. 6) these South Indian populations were named *P. schisticeps horsfieldii* and *P. s. travencorensis*, though *horsfieldii* was described before Hodgson described the rusty-flanked population *schisticeps* from Nepal.

4) On Plate 92 two sub-species of the Slaty-blue Flycatcher (*Muscicapa leucomelanura*) have been illustrated, but they have been captioned the wrong way around, Fig. 17 with a rufous throat and breast is the subspecies *minuta* found in the north-eastern Himalaya, also resident in Burma, Laos and N.W. Tonkin. The nominate subspecies *leucomelanura* with a white breast, occurs in the Himalaya and

as far west as Pakistan and is illustrated in Fig. 18, but with the wrong distribution and subspecies description.

Illustrator's Errors

Again, the authors would like to stress that the Pictorial Guide, with so many species illustrated in colour and with female and immature plumages, far surpasses anything which has hitherto been available. There are, however a few misleading illustrations with respect to key field characters and diagnostic features and this commentary would be incomplete without referring to a few of them.

Raptors

These are notoriously difficult to illustrate adequately because of the wide plumage variation exhibited by many adult species, plus differences in sub-adult plumages. A very brave attempt has been made to cover this wide variation.

On Plate 19, the two illustrations of adult female Marsh Harrier, *Circus aeruginosus*, are very misleading. Female birds of all ages are very dark chocolate brown on the belly and upper-parts, with variable amounts of golden yellow on the crown and leading edge of the wing, and they are identical to the illustration of the immature. Fig. 5 depicting the underside view of female looks more like an immature male.

On Plate 22 the Indian Sparrow-hawk or Shikra (*Accipiter badius*) depicts a female which is quite dark brown in contrast to the male. In the drier parts of central India and in Pakistan, typical females are much paler and greyer on the upperparts, often being paler than males in the experience of all three authors, with size difference and more conspicuous tail barring being the best field points for determining sex.

On Plate 29, the female Lesser Kestrel (*Falco naumanni*), appears to be an immature male and is certainly not a female, which at all ages lacks any blue-grey on the crown, nape and central tail feathers (all prominent in the illustration). The female Lesser Kestrel has a wholly rufous tail, cross-barred black, and a rufous crown and nape and the majority of females are also strongly streaked on the breast.

Charadriformes

This is another very difficult group to illustrate adequately in a field guide, because of the differences between breeding and non-breeding dress and the often striking patterns only revealed in flight. The Pictorial Guide is undoubtedly the most comprehensive attempt to date, to illustrate the waders of the subcontinent.

On Plate 39, the Asian Dowitcher (*Limnodromus semipalmatus*) shown in Fig. 12 should show a white, grey-barred rump, concolorous with the mantle. It has been shown white in the plate.

On Plate 44, the Oriental Pratincole (*Glareola pratincola maldivarum*) illustrated in Fig 3, is wrongly depicted as having a white trailing edge to the wings. Furthermore the mantle of *G. pratincola maldivarum* should be darker in tone than that of the Collared Pratincole (*Glareola pratincola pratincola*). The white trailing edge to the wing of the Collared Pratincole correctly shown in Fig. 2, is an important field character separating it from the Oriental Pratincole. Most authors treat them as separate species, *Glareola maldivarum* and *Glareola pratincola* (Cramp & Simmons 1983 and K. M. Voous, op. cit. 1977).

On Plate 45, the Brown-headed Gull (*Larus brunnicephalus*) depicted in Fig. 13 as an immature bird, is in fact a typical adult in winter

plumage. Immature or first winter birds have a dark brown terminal band to the tail, as well as some brown mottling across the wing coverts. The immature also lacks the white spots (mirrors) to the black wing tips.

Finally several printer's errors are noted. On Plate 45, the words at the bottom of the plate, 'from below', are misleading. In the systematic list on page 46 listing Pycnonotidae, No. 1128, should read 'Red-vented' not 'Revented' Bulbul. On page 67, 'Black and White Grosbeak' No. 1982, should read Black and Yellow Grosbeak.

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ECOLOGICAL DISTRIBUTION OF *RATTUS MELTADA* IN INDIA[1]

B. D. RANA[2]

(*With two text-figures*)

INTRODUCTION

The metad, *Rattus meltada* inflicts severe losses to various standing crops and grasslands (Rana and Prakash 1980) in India. Biology of this field rodent has been investigated in detail at Central Arid Zone Research Institute, Jodhpur (Rana and Prakash 1980, 1984).

Very little is known about its ecological evaluation in Indian sub-continent. Therefore, to fill up this gap, this investigation was undertaken and inter-relationships with physical and biotic environments have been reported in this communication.

METHODS

The soft-furred field rats, *Rattus meltada* were collected at one locality in each of the eleven administrative districts during 1968 and from January 1978 to December 1979 in south eastern parts of Thar desert. At each habitat, two traplines constituting 30 snap traps in each line at an interval of 10 metres, were fixed in a homogeneous vegetational community. These two trap lines were 15 metres apart from each other and installed for 72 hours. Snap traps were baited with peanut butter. The frequency of capture of the metad is expressed as the percentage of total number of rodents collected in a habitat. Observations on their ecological attributes were also recorded in the field. The following abbreviations are used in text:

R. m. p. = *Rattus meltada pallidior, M. m.* = *Mus musculus, M. b.* = *Mus booduga, G. e.* = *Golunda ellioti* and *B.b.* = *Bandicota bengalensis.*

Ecological distribution

Irrigated crop field biotope

The soft-furred field rat, *R. m. pallidior* inhabits wheat, groundnut and sugarcane crop fields in Punjab, Union territory of Delhi, Uttar Pradesh, Haryana and Gujarat (Mann, 1969, Sagar and Bindra 1973, Peshwani *et al.* 1975 and Bhatnagar 1965) respectively (Fig. 1). The other subspecies *R. m. meltada* commonly occurs in most of the parts of southern India (Fig. 1), representing Maharashtra (Salunkhe *et al.* 1980), Andhra Pradesh (Rajaskharan & Dharam Raju 1975), Karnataka (Chandrahas & Krishnaswami 1974), Kerala (Natrajan 1975) and Tamil Nadu (Ayyar 1931). *R. m. meltada* usually prefers Ragi, Rice, groundnut and Jowar crops, grown frequently in these States of India (Table 1).

In the western Rajasthan this rat lives in cracks, or shallow and simple burrows in the crop fields (Rana & Soni 1981). Out of all the *R. m. pallidior* collected during 1971, 1978 and 1979 study periods, 72.7 per cent were from irrigated crops of cotton (*Gossipium hirsutum*), wheat (*Triticum aestivum*), Brown

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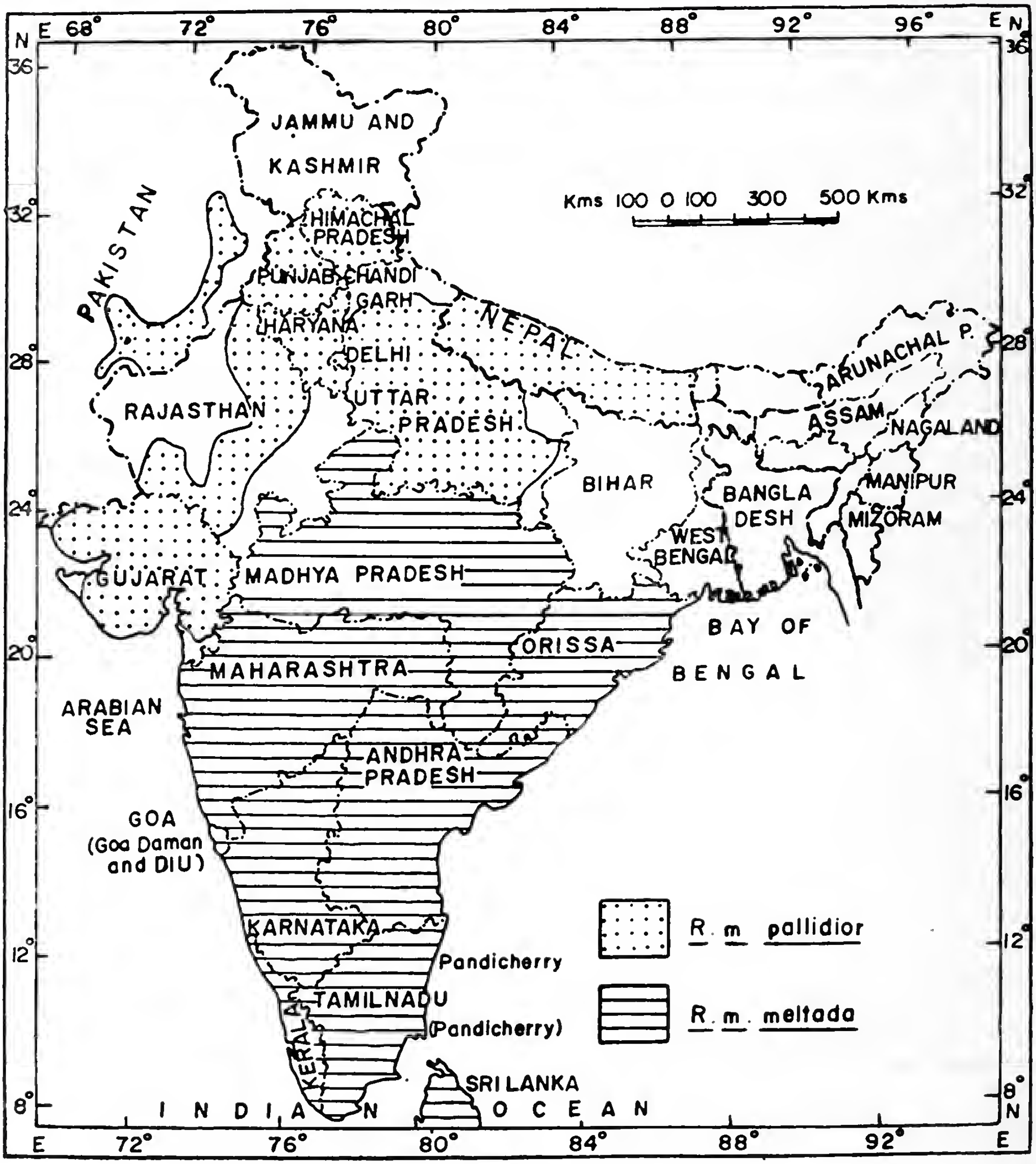

Fig. 1. Distribution of *Rattus meltada* in India.

TABLE 1

ECOLOGICAL DISTRIBUTION OF *R. meltada* IN INDIA

Subspecies	States	Soil types	Annual rainfall (mm)	Main crops
Rattus meltada pallidior	Rajasthan desert	Yellow & Red soil	500	Cotton, Wheat & Jowar
,,	Punjab	Alluvial	620	Sugarcane
,,	Haryana	Alluvial	620	Wheat and sugarcane
,,	Delhi	Sandy loam	620	Wheat and barley
,,	Uttar Pradesh	Red soil	990	Wheat and sugarcane
,,	Gujarat	Sandy loam	725	Groundnut and jowar
Rattus meltada meltada	Madhya Pradesh	Red & black	1240	Bajra and jowar
,,	Maharashtra	,,	1620	Bajra, groundnut and jowar
,,	Andhra Pradesh	,,	1000	Rice and Ragi
,,	Karnataka	,,	1330	Ragi and Rice
,,	Kerala	,,	3010	Rice and coconut
,,	Tamil Nadu	,,	1020	Rice & Ragi

TABLE 2

PER CENT RODENTS IN RELATION TO VARIOUS CROPS IN SOUTH EASTERN RAJASTHAN DESERT

Crops	Months of the year										
	January		February		March			April		May	
	R. m. p.	*M.m.*	*R. m.p.*	*M. b.*	*R. m.*	*M.b.*	*G.e.*	*R.m.p.*	*G.e.*	*R.m.p.*	*G.e.*
Cotton	38.8	—	47.6	—	—	—	—	—	—	—	—
Wheat	38.8	5.5	38.0	4.7	54.5	4.5	9.0	40.0	40.0	—	—
Mustard	16.6	—	9.5	—	13.6	—	—	—	—	—	—
Barley	—	—	—	—	9.0	—	9.0	20.0	10.0	—	—
Jowar	—	—	—	—	—	—	—	—	—	38.8	27.7
Maize	—	—	—	—	—	—	—	—	—	11.1	22.2

Crops	Months of the year										
	June		August		September		October			December	
	R. m. p.	*M.b.*	*R. m. p.*	*R. m. p.*	*B.b.*	*R.m.p.*	*G.e.*	*B.b.*	*R.m.p.*	*M.b.*	*B.b.*
Cotton	—	—	—	33.3	11.1	83.3	11.1	5.5	72.3	3.8	3.8
Wheat	—	—	—	—	—	—	—	—	20.2	—	—
Mustard	—	—	—	—	—	—	—	—	—	—	—
Barley	—	—	—	—	—	—	—	—	—	—	—
Jowar	37.4	37.4	60	—	—	—	—	—	—	—	—
Maize	25.0	—	40	55.5	—	—	—	—	—	—	—

sarson (*Brassica campestris*) and barley (*Hordeum vulgare*) during first half of the year (Table 2). During May to August, metad invaded the jowar (*Sorghum vulgare*) and maize (*Zea mays*) crop fields.

After the harvesting of these crops, it infested the cotton crops from September to December. Results tend to indicate that this rodent migrates from one crop to another in relation to its maturity (Table 2). It was also reported from ruderal habitat in Thar desert (Prakash *et al.* 1971). In Sri Ganganagar district of north western Rajasthan, where agroclimatic conditions are altogether changed, it infests the crops of gram, sugarcane, cotton and wheat (Prakash *et al.* 1971).

Scrub grassland biotope

In western Rajasthan, this rodent is usually found under thickets of *Dichanthium annulatum* in Jhunjhunu, Nagaur and Jodhpur regions (Prakash *et al.* 1971). This metad was also collected from gravel scattered habitat, though in low numbers. Data reported in this investigation reveals that rangeland community is distributed on sandy plains with sparse vegetation due to regular cultivation and irrigation practices either through canal or dug wells in Sri Ganganagar, Pali, Jhunjhunu, Nagaur, Jodhpur and Sirohi districts of the Thar desert (Fig. 2).

Sandy plains

Secondly, scrub grassland, where moderate soil moisture is available all the year round to the vegetation. The vegetation cover was worked out at 7.3 per cent (Prakash and Rana 1972) which is quite high rate for desert region. 20 per cent of *R. m. pallidior* were collected in earlier study from rocky habitat at Pali district (Prakash *et al.* 1971).

Alam (1974) and Taber *et al.* (1967) reported its occurrence in Bangladesh and Pakistan respectively. This metad is also well distributed even in the foot hills of eastern parts of Himalaya (Verma & Mahadevan 1973).

Interrelationship with physical environment

Relationship with rainfall

Table 1 reveals that *R. m. pallidior* is spread over the Punjab, Delhi, Uttar Pradesh, Haryana, Rajasthan and Gujarat localities, where annual amount of precipitation varies from 300 to 725 mm whereas, another subspecies *R. m. meltada* is distributed in relatively higher rainfall zones of southern India such as Madhya Pradesh, Orissa, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu. The annual rainfall in these States varies from 1000 to 3010 mm. Besides this, it is well distributed in high rainfall zone of eastern region of Himalayan foothills (Verma & Mahadevan 1973) (Fig. 1). The rainfall and the resultant humidity help the rodent in burrowing which is mostly vertical in comparison to horizontal burrows made by other species of desert rodents. The relative abundance of *R. m. pallidior* is directly in proportion to the rainfall and is inversely proportional to the aridity index. Similar observations were made by Newsome (1969) in Australian desert rodents.

Relationship with edaphic factors

When the soil texture of different states of India in relation to the distribution of *R. meltada* was considered, the following important points emerged: *R. m. pallidior* usually prefers alluvial and duny soil represented in Punjab 47.0 per cent, Delhi, Uttar Pradesh, Haryana and Gujarat states of India whereas, the *R. m. meltada* inhabits the black soils, found in southern states of India (Table 1).

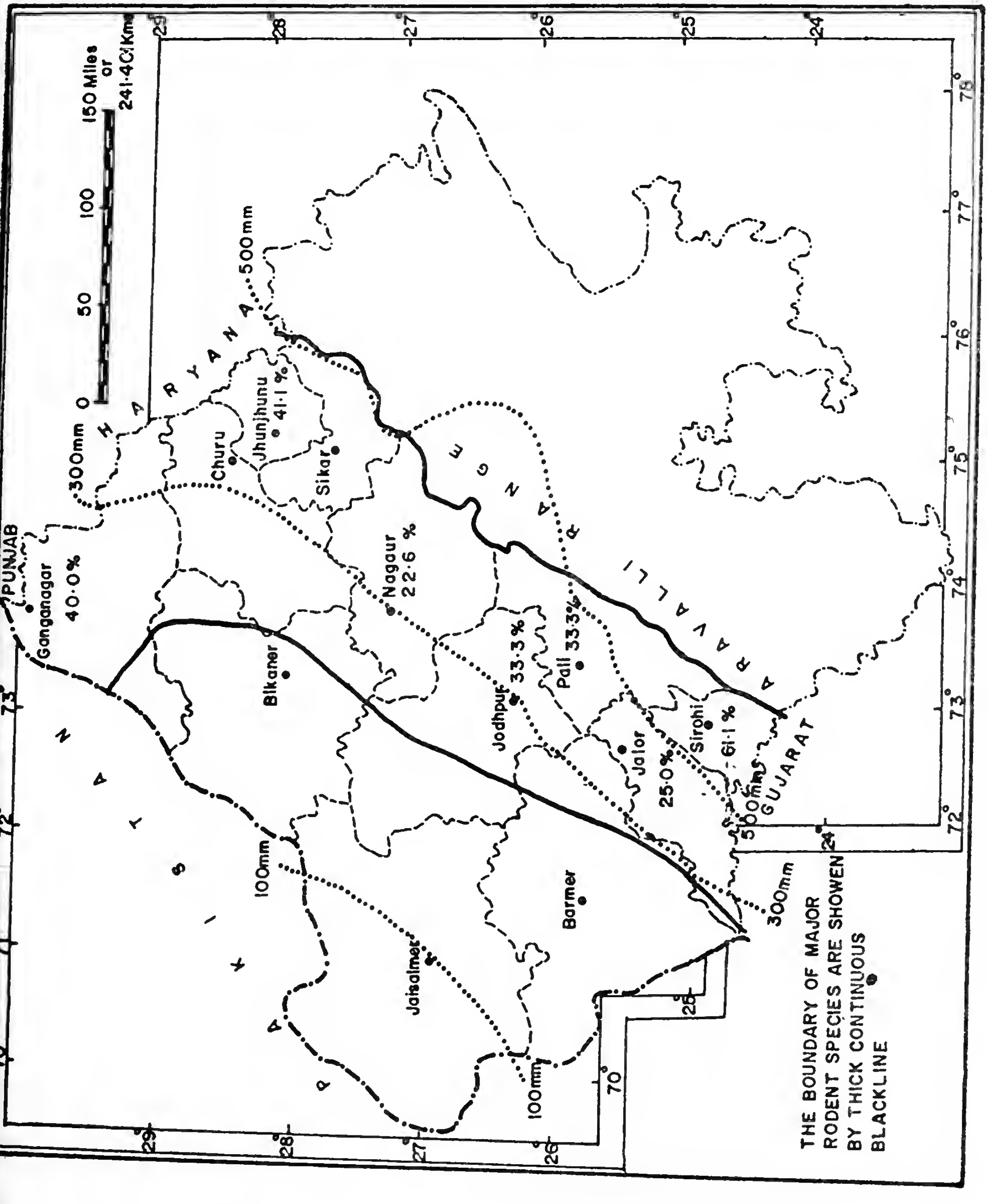

Fig. 2. Ecological distribution of *R. m. pallidior* in Western Rajasthan.

R. m. pallidior occurs (Prakash *et al.* 1971, Prakash and Rana 1972) in red desertic soils of Nagaur ((22.6%), Jodhpur (33.3%) and duny soils of Jhunjhunu (41.1 per cent) districts in Western Rajasthan desert (Prakash & Rana 1972, Rana 1981), (Fig 2). The soils of Pali (33.3 per cent) Jalor (25.0 per cent) and Sirohi (61.1 per cent) districts of south eastern desert is situated at the foothills of Aravalli ranges are red and yellow, where *R. m. pallidior* occurred in relatively greater numbers (Fig. 2). The soils of crop fields in Sirohi are more clayey and consolidated preferred by *R. m. pallidior* (72.2 per cent, Rana 1981) for burrowing activity. Likewise, in Ganganagar districts *R. m. pallidior* was found to prefer this soil in gram (40.0 per cent), cotton and wheat (28.5 per cent) and sugarcane (16.6 per cent) crop fields (Prakash *et al.* 1971). The *R. m. pallidior* were not collected from duny soils of Bikaner and Jaisalmer districts (Prakash *et al.* 1971) in western Rajasthan desert.

Relationship with basal cover of vegetation

It is evident that the number of *R. m. pallidior* is directly correlated with the basal cover. 61.1 per cent of the rodents trapped were *Rattus meltada pallidior* where the basal cover was highest (7.3 per cent) in Sirohi, Southeastern Rajasthan desert (Prakash *et al.* 1971). The lowest number of rodents (12.1 per cent) were collected in *Cyperus arenarius*-*Aristida* spp. (1.0 per cent). In the *Pulicaria wightiana* — *Sesbania aegyptiaca* — *Aristida* spp. community, where the basal cover was 1.3 per cent, the frequency of metads was in median position. These observations point out that the basal cover of vegetation and the frequency of *Rattus meltada* bear a direct relationship. However, the basal cover does not have direct bearing upon relative abundance of *Meriones hurrianae* in Indian desert (Prakash 1972).

Interrelationship with biotic environment

Relationship with other small mammals

In northern India, *R. meltada* is associated with *Tatera indica*, *Mus booduga* and *Mus musculus*. In southern India, which receives relatively more rainfall *Bandicota bengalensis* occurs with them along with *Tatera indica*. *R. m. pallidior* is found in Sri Ganganagar and Jhunjhunu districts of northern Rajasthan along with *Tatera indica* and *Meriones hurrianae* (Prakash *et al.* 1971). Jhunjhunu and Nagaur districts along with the former species of rodent of the Central desert *Rattus meltada* was found along with the *Mus platythrix sadhu* (Prakash and Rana 1972), *Tatera indica* and *Mus* spp. also occurred with this rodent (Prakash *et al.* 1975). But a very recent survey conducted by Rana (1981) established that *R. meltada pallidior* is usually found along with the *Suncus murinus sindensis*, an insectivore and *Golunda ellioti* in south eastern fringes of Thar desert.

Summary

The soft-furred field rat, *Rattus meltada* is the most abundant rodent in the Indian subcontinent. It occurs in crop fields and scrub grassland habitats in India but it usually prefers the former. It appears that it is more commonly found in crop fields having wheat and sugarcane as chief crop components in northern India. In southern India, it is found in the Ragi and Rice crop fields environment. In western Rajasthan desert, the frequency of *R. meltada pallidior* is highest in cotton crop fields among irrigated crops. *Rattus meltada pallidior*, the north Indian rodent and *Rattus*

meltada meltada, south Indian race prefer alluvial duny soils and black soils respectively. In most parts of India, it is associated with *Tatera indica, Mus booduga* and *Bandicota bengalensis.* The relative abundance of *R. meltada* in various states of India and its frequency in different vegetational communities are discussed and it is found to be directly related with the amount of precipitation and inversely proportional to the aridity index.

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ECOLOGICAL OBSERVATIONS ON *SCHIZOTHORAX RICHARDSONII* (GRAY)[1]

S. P. BALONI[2] AND RAJ TILAK[3]

INTRODUCTION

Garhwal Himalaya possesses a large number of rivers and streams with fishery potential. This region of Uttar Pradesh is entirely hilly from where a number of torrential rivers and hill-streams originate and flow to the plains of northern India. Agriculture is poorly developed in Garhwal Himalaya. As a viable alternative to agriculture, pisciculture can supplement the food scarcity in the area because of the presence of vast water resources. *Schizothorax richardsonii* is abundant in hill-streams and rivers of the Garhwal region, being the most important food and game fish of the region. It grows to a large size. No work is available on the bio-ecology of this species in Garhwal Himalaya, except that of Baloni (1979) who studied breeding behaviour of this species. With this view detailed studies on the ecology of *S. richardsonii* were conducted. In the present study the habits and habitat, food and feeding habits, sexual dimorphism, breeding period and behaviour, and their correlation with physico-chemical conditions of the rivers and streams have been covered.

Schizothorax richardsonii (Gray) is the principal fish of the waterways in Garhwal hills. A bottom inhabitant of streams and rivers with rocky and stony bed, it is well adapted to the icy cold, super-oxygenated and fast flowing waters of Garhwal at various altitudes. As a measure of adaptation to the hill-stream environment, the fish has acquired a cylindrical tapering form of the body, broadening of the head, reduction of the scales and horizontally placed paired fins. The papillated hard plate on the ventral surface of the head is not adhesive in function (Tilak, unpublished). So the fish moves against the fast current only by the muscular efforts of the body, for which the body musculature is well developed.

FOOD AND FEEDING HABITS

A bottom feeder it is predominently herbivorous. The gut contents include diatoms (*Amphora, Cocconeis, Cymbella, Pragilaria, Gomphonema, Gyrosigma, Navicula, Nitzschia, Synedra* and *Tabellaria*), algae (*Chlorella, Chlamydomonas, Cladophora, Chara, Dichotomosiphon, Hormidium, Hydrodictyon, Microspora, Pithophora, Zygnema, Ulothrix, Spirogyra, Gleotrichia, Microcystis* and *Rivularia*) and macrophytes (*Potamogeton* and *Polygonum*). The diatoms found in abundance are *Cymbella, Gyrosigma, Navicula* and *Synedra.* The algae recorded in abundance in the gut contents are *Cladophora, Hydrodictyon, Pithophora, Zygnema, Spirogyra* and *Rivularia.* Macrophytes are only occasionally found.

The intensity of feeding decreases slightly during the spawning period (July to September). In the pre-spawning period (April to June), feeding is at its peak. After spawning, the fish again feeds voraciously up to November. This appears to be correlated with the

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phenomenon of vitallogenesis. The amount of food and the rate of feeding is not uniform, depending on reproductive stages of the fish and turbidity of the water.

The sharp horny jaws help the fish in scraping off diatoms and algae from the surface of the rocks and stones. The suctorial disc on the ventral surface of the lower jaw is unable to fix the fish on the stones while feeding on algal layer in strong current. It rasps off algae in small installments making a series of crescentic impressions on the rock (Tilak 1972).

The bottom feeding habit of the fish is correlated with the ventral position of the mouth and indicated by presence of sand particles in appreciable quantity in the gut contents. The mouth is narrow, jaws edentulous and the buccal cavity depressed. The gill rakers are large, hair-like, compactly arranged processes and constitute an efficient sieve-like apparatus. They, thus, protect the delicate gill filaments from the harmful effect of silt. Absence of stomach and presence of a long and convoluted alimentary canal indicates the herbivorous feeding habit of this fish.

The length of the alimentary canal in specimens of 80 mm to 560 mm total length ranged between 197 mm and 2520 mm and the relative length of the gut between 2.213 and 5.082.

Sexual Dimorphism

The mature male and female can be distinguished as follows:

(1) In the male, the snout is blunt while in the female, it is pointed.

(2) The snout is tuberculated in the mature male and non-tuberculated, in the female.

(3) The anal fin is long and when adpressed, reaches the base of the caudal fin only in the male.

(4) Mature males are lighter in colour than mature females and have a straight ventral profile while the mature females are heavier than the males and have enlarged and distended bellies. The Males are always smaller in size than females.

Breeding Behaviour

A monsoon breeder, the breeding season is from July to early October. As the breeding season approaches, the fish begin to show excitement. They leap out of the water at waterfalls and migrate upstream in search of shallow spawning grounds along banks of streams. The fish cannot lay eggs in midstream due to the violent force of the water-current as they are liable to be swept away. So the shallow waters on the sides are preferred where the act of spawning takes place. The fish spawns several times during the breeding season on cloudy and rainy days.

The ovaries are paired, elongated structures, free for the large part of their length and fused with one another at the hind end. In the early growth phase, they are flaccid, delicate and translucent structures of a dirty brown colour, becoming much distended and enlarged during the breeding period, when they take on a yellowish colour and present a mulberry fruit like shape, due to the presence of the large ova inside.

In the cold winter months, ovaries are in the resting phase. From March onwards, the climatic conditions become favourable and the final stages of maturation occur during this period.

The diameter of mature ova ranges between 2.99 and 3.992 mm. The fecundity of the fish in the size range 190-560 mm in total length ranges between 1578 and 14316.

The size at the first maturity for the female is 175 mm, and for male 140 mm.

In the fry of *Schizothorax richardsonii*, a black lateral band ending in a black spot at the base of caudal fin is present. The fry and fingerlings are abundant in the shallow spawning grounds and can be collected easily for extensive culture of the fish.

Discussion

S. richardsonii is a bottom feeder and a predominently herbivorous fish (Khanna & Pant 1964, Subla & Das 1970).

A true stomach is not present in this fish. The oesophagus is followed by an intestinal bulb. Khanna & Pant (1964) and Nath (1979) are of the opinion that presence of intestinal bulb compensates for the absence of stomach in herbivorous fishes. The intestinal bulb is wide and spacious and leads into the intestine which is long, thin walled and highly coiled with several loops (Chatterji *et al.* 1978).

In the juveniles of *S. richardsonii*, the relative length of the gut is less than the adults as they feed on aquatic insects and their larvae and nymphs. But in the adults, the relative length of the gut is more, indicating that the fish is totally herbivorous in the adult stage. The scraping mechanism is absent in the jaws of the young stages and therefore, they feed on the available insect larvae in the same habitat.

Shrestha & Khanna (1979) studied the gonado-somatic index and histology of the ovary in *Schizothorax richardsonii* (*S. plagiostomus*) and concluded that the fish spawns twice a year, once from mid-September to October and secondly in March. Bhatnagar (1964) also recorded two spawning periods for this fish but according to him they were July to August and December to January. On the contrary, Bisht & Joshi (1975) stated that *S. richardsonii* spawns in Nainital lake only once from late October to December. In the present study, only one breeding period has been observed for *S. richardsonii* which falls between July and October. During this period, the mean temperature of water was 18.5-22.5°C, pH 7.1-7.5 and rainfall 15.3 to 19.5 mm. Shrestha & Khanna (op. cit.) also mentioned temperature of water between 20.60-21.5°C, pH ranged between 6.5-7.2 and rainfall between 32.00-221.20 mm. But the second breeding period mentioned by Shrestha & Khanna (op. cit.) falls in March when temperature of water was 18.0°C, pH 7.6 and rainfall 30.0 mm. During this month, in the streams and rivers of Garhwal region, the water temperature was 13.4-16.4°C, pH 7.2-8.0, rainfall 2.0-17.9 mm and the fish does not breed. Bisht & Joshi (1975) studied the histology of ovary and gonado-somatic index of *S. richardsonii* and found that the fish spawns only once during a year, that is from late October to December. Baloni (1979) reported that this species breeds from mid-June to September. The variation in the breeding period of the same species in Nainital lake and streams and rivers of Garhwal may be due to different ecological conditions in the lacustrine and riverine environment of the two different areas.

In other Schizothoracids, such as *Schizothoraichthys niger* and *S. esonicus*, the breeding period has been variously described by different workers in Kashmir. According to Raina (1976), the breeding season of *Schizothoraichthys esocinus* collected from Dal lake, extends from April to late June. According to Malhotra (1965), on the basis of the morphological conditions of the ovaries, the breeding season of *S. niger* is from January to March, Malhotra (1970) observed the breeding season of *S. niger* from middle of April to middle of June on the basis of histological studies of the oocytes, the study of the diameter of oocytes and gonado-somatic index; he pointed out that the

breeding season depends upon the optimum extroceptive factors like food, temperature and light, both for the parent as well as the offsprings. Jyoti & Malhotra (1972) stated that *S. niger* breeds from March to May, thus, the breeding season of the same species (*S. niger*) is described differently by the same authors in different publications (Malhotra 1965, 1970, Jyoti & Malhotra 1972).

It has been observed in the present study that survival rate of juveniles of *S. richardsonii* is highest in these rivers and streams. The fecundity of this fish is also high. The high concentration of population of this species in the streams of this area is due to proper adaptation of the species to the environmental conditions of these streams and selection of suitable spawning grounds.

Water temperature plays an important role in the various vital activities of the fish. The water temperature of snow-fed rivers ranges between 6.0-21.8°C and spring-fed hill streams ranges between 7.2-28.5°C. The lowest water temperature is recorded during January and February and highest during May and June. The winter low temperature is associated with the low feeding intensity and resting phase of gonads. During summer months this fish is found in deep pools in the mid-stream where water temperature ranges between 16.3-24.5°C and atmoshpheric temperature ranges between 33.0-44.6°C. The temperature tolerance of *S. richardsonii* ranges from 6.0 to 24.5°C. Sehgal (1973) reported that the temperature tolerance of *S. richardsonii* (*O. plagiostomus*) ranged from 8.0°C to 22.0°C in Himachal Pradesh waters. This species breeds in the monsoon season when temperature remains uniformly constant between 18.5°C and 21.5°C. From March onwards, when temperature becomes favourable, the fish feeds actively and final stages of maturation are attained.

The hill-streams and rivers are well-oxygenated, clear and pure. *S. richardsonii* is found in the water where concentration of dissolved oxygen ranges from 8.2 ppm to 24.6 ppm. Due to well-oxygenated water of hill-streams and rivers, the fish is found in abundance in these waters. The high concentration of dissolved oxygen is associated with the rapid flow of water, due to clarity of water, the sunrays penetrate the water and are utilised by the phytoplanktons in the process of photosynthesis. The pH of the rivers and streams under study here ranges between 7.0-8.3. No adverse effect has been observed on the fish within this range of pH. Neutral and alkaline pH is usually favourable for fish. Alkaline waters supporting a large amount of fish food indirectly support higher fish population and is favourable for the growth of plankton (Das & Srivastava 1956, Das 1961, 1967, Sreenivasan, 1963). Alkaline waters are favourable in inducing the carps to spawn, this range of pH is conducive to fertilisation and further maturation (Khan 1945, Joshi 1980).

The turbidity in the snow-fed rivers starts increasing from April onwards due to melting of snow; highest turbidity is recorded in monsoon months due to excessive rainfall. In the spring-fed streams, the water becomes turbid during monsoon months because of monsoon rains and clears during rest of the year. The highest (8606.4 ppm) and lowest (0.4 ppm) turbidity ranges were associated with the minima and maxima of phytoplanktons, dissolved oxygen respectively. The turbidity also effects the feeding activity of fish. During monsoon months, due to high turbidity in the waters of hill-streams and rivers, the fish is unable to detect its food. It also hinders photosynthesis and growth of the phytoplanktons.

The quantity of free carbon dioxide is very

low (0.1-5.4 ppm) in the hill-streams and rivers under study here and has no adverse effect on the fish.

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STUDIES ON THE INDIAN STRACHIINI (PENTATOMIDAE: PENTATOMINAE)[1]

M. Nayyar Azim and S. Adam Shafee[2]

(With two text-figures)

The tribe Strachiini is redefined. Key to Indian genera of the tribe is given. Additional generic characters of male and female genitalia are proposed. *Bagrada picta* (Fabricius) and *Eurydema pulchrum* (Westwood) are illustrated; *Stenozygum parspeciosum* sp. nov. is described and illustrated.

Introduction

Mulsant & Rey (1867) proposed the group Strachiaires under Pentatomiens. Stal (1872), Leston (1958), De la Fuente (1971) and Gross (1976) recognised Mulsant & Rey's (1867) group as division Strachiaria, subfamily Strachiinae, tribe Strachiini and group Strachia respectively.

The genera *Strachia* Hahn and *Eurydema* Laporte have many common characters and it is desirable to place them under one group. The group name Strachiaires Mulsant & Rey has priority over Eurydemaria Distant. Therefore, the latter name is dropped.

We follow De la Fuente (1971) in recognising Strachiini as tribe under the subfamily Pentatominae.

DIAGNOSIS: Body brilliantly coloured with metallic iridescent; head wider than long, juga with lateral margins reflexed; rostrum slender, 4-segmented, extending to or beyond middle coxae; antennae 5-segmented; pronotum with anterolateral margins smooth and slightly reflexed, humeral angles usually obtuse, scutellum gradually narrowing apically, extending beyond middle of abdomen; metasternal scent gland ostiole, peritreme and evaporatoria indistinct; mesosternum with longitudinal carina medially; fore legs with femora unarmed; abdominal venter unsulcated and unarmed at base; spermatheca with proximal part of sclerotised tube broad and bulbous, bulb usually without tubular outgrowths; female genitalia plate-like type.

The tribe is represented by four genera from India and a key for their separation is given below:

Key to Indian genera of the tribe Strachiini Mulsant & Rey

1. Pronotum with anterolateral margins straight, humeral angles obtuse; first antennal segment never reaching apex of head...............2
— Pronotum with anterolateral margins deeply sinuate, humeral angles much acute; first antennal segment reaching beyond apex of head (Distant, 1902: fig. 118; Ahmad *et al.*, 1974: fig. 73) ....*Strachia* Hahn, 1831
2. Bucculae shorter than first rostral segment; second antennal segment longer than third (figs. 1A, 2B); spermatheca (figs. 1C, 2F) with proximal flange large..........................3
— Bucculae as long as first rostral segment; second antennal segment shorter than third (fig. 2J); spermatheca (fig. 2M) with proximal flange small, distal part of duct moderately long and uncoiled; female genitalia (fig. 2L) with first gonocoxae quadrate apical angle projecting laterally.............*Stenozygum* Fieber, 1861

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3. Pronotum with anterior margin slightly concave; last tergum (fig. 1D) in female with posterior margin deeply concave; female genitalia (fig. 1B) with first gonocoxae much broad, spermatheca (fig. 1C) with distal part of duct small; male genitalia with claspers (fig. 1F) comma-shaped, subgenital plate (fig. 1 I) anteriorly with a prolongation ....*Bagrada* Stal, 1862
— Pronotum with anterior margin deeply concave; last tergum (fig. 2D) in female with posterior margin convex; female genitalia (fig. 2E) with first gonocoxae narrow, spermatheca (fig. 2F) with distal part of duct long and coiled; male genitalia with clasper (fig. 2G) plate-like bearing long spine-like process apically, subgenital plate (fig. 2H) anteriorly without prolongation ....*Eurydema* Laporte, 1832

1. Genus *Strachia* Hahn

Strachia Hahn, 1831: 180

Type-species: *Strachia crucigera* Hahn

Body brilliantly coloured; head distinctly wider than long; juga longer than tylus and meeting apically, lateral margins reflexed; rostrum extending upto hind coxae; antennae 5-segmented, first segment reaching beyond apex of head; antenniferous tubercles slightly visible from above; pronotum with anterior margin deeply concave, anterolateral margins deeply sinuate, humeral angles acute; scutellum well developed; mesosternum with a longitudinal carina medially; metasternal scent gland ostiole, peritreme and evaporatoria indistinct; abdominal venter unsulcated and unarmed at base.

Strachia crucigera Hahn

Strachia crucigera Hahn, 1831: 184.

Strachia crucigera Hahn; Distant, 1902: 195.

Strachia crucigera Hahn; Ahmad *et al.*, 1974: 50.

Material examined. IARI, New Delhi Collection: 1 ♀, Bengal, Dacca, 15.i 1906 (R-2103); 1 ♀, Bengal, Dacca, 11.i. 1906 (R-2104); 1 ♀, Bengal, Dacca, 11.i. 1906 (R-2102).

2. Genus *Bagrada* Stal

Bagrada Stal, 1862: 105.

Type-species : *Cimex picta* Fabricius

The genus *Bagrada* was first proposed by Stal (1862) with *Cimex picta* as its type. Mulsant & Rey (1867) proposed *Nitilia* as subgenus under *Bagrada* Stal. The genus has been thoroughly revised by Horvath (1936). He arranged 25 species under three subgenera: *Bagrada* S. str., *Nitilia* Mulsant & Rey and *Ayeshella* Horvath.

Head distinctly wider than long; juga longer than tylus and meeting apically, lateral and apical margins reflexed; rostrum extending upto hind coxae, bucculae shorter than first rostral segment; antennae 5-segmented, first segment nearly reaching apex of head; antenniferous tubercles slightly visible from above; pronotum with anterolateral margins reflexed, humeral angles obtuse; scutellum short and triangular; mesosternum with a longitudinal carina medially; metasternal scent gland ostiole, peritreme and evaporatoria indistinct; abdominal venter unsulcated and unarmed at base. Some additional generic characters are suggested which are as follows: last tergum in female (fig. 1D) with anterior margin straight, posterior margin broadly notched medially. Female genitalia: external plates (fig. 1B), first gonocoxae much enlarged and quadrate, 8th and 9th paratergites very small; spermatheca (fig. 1C), proximal part of sclerotised tube broad and bulbous, bulb oblong without outgrowths, distal part of duct small, proximal flange large. Male genitalia: claspers (fig. 1F) comma-shaped, pseudoclaspers (fig. 1G) spatulate; subgenital plate (fig. 1 I), anterior margin with a prolongation medially.

Bagrada picta (Fabricius)
(Fig. 1 A-I)

Cimex picta Fabricius, 1775: 715.

Bagrada picta (Fabricius); Stal, 1862: 105.
Bagrada picta (Fabricius); Distant, 1902: 193.
Bagrada picta (Fabricius); Horvath, 1936: 23, 28.

Material examined. 8 ♀, 8 ♂, INDIA: Uttar Pradesh, Aligarh, University Botanical garden, on *Brassica compestris* Linn., 27.vii.1977 (M. Nayyar Azim); 6 ♀, 8 ♂, 5.iv.1978, rest of data same as above.

IARI, New Delhi Collection: 1 ♀, Saharanpur, Botanical garden, on Mustard and Cabbage, 30.ix.1917 (R-139); 1 ♀, U.P., Saharanpur, Botanical garden, 19.iv.1909 (R-406); 1 ♀, U.P., Saharanpur, Botanical Garden. 19.iv.1909 (R-390); 1 ♂, (Saran & Mackanzie Coll., R-412); 1 ♂, Saharanpur, Botanical garden, on Mustard and Cabbage, 30.iv.1917 (R-148); 1 ♀, Chendwora, 22.iii.1922 (C. P. Coll., R-503); 1 ♀, Pusa, 18.ii.1921 (S. C. Sarkar Coll., R-551).

3. Genus *Eurydema* Laporte

Eurydema Laporte, 1832 : 61.
Type-species: *Cimex oleraceum* Linnaeus.

Head distinctly wider than long; juga distinctly longer than tylus and meeting apically, lateral margins reflexed; rostrum extending beyond middle coxae, bucculae shorter than first rostral segment; antennae 5-segmented, first segment not reaching apex of head; antenniferous tubercles slightly visible from above; pronotum with anterior margin deeply concave, anterolateral margins straight, humeral angles obtuse; scutellum well developed, subacute apically; mesosternum with a longitudinal carina medially; metasternal scent gland ostiole, peritreme and evaporatoria indistinct; abdominal venter unsulcated and unarmed at base. Some additional generic characters are suggested which are as follows: last tergum in female (fig. 2D) with anterior and posterior margins convex. Female genitalia: external plates (fig. 2E), first gonocoxae quadrate, inner margin straight, paratergites 8th triangular. 9th oblong; spermatheca (fig. 2F), proximal part of sclerotised tube slightly broad and bulbous, bulb semicircular and without tubular outgrowths, distal part of duct long and coiled, proximal flange large. Male genitalia: claspers (fig. 2G) platelike bearing a long spine like process apically, subgenital plate (fig. 2H), anterior and posterior margins convex and concave respectively.

Eurydema pulchrum (Westwood)
(Fig. 2 A-H)

Pentatoma pulchrum Westwood, 1837: 34.
Strachia pulchrum (Westwood); Dallas, 1851: 258.
Eurydema sumatrana Ellenrieder, 1862: 152.
Strachia designata Walker, 1867: 327.
Eurydema pulchrum (Westwood); Stal, 1876: 86.
Eurydema pulchrum (Westwood); Distant, 1902: 190.
Eurydema pulchrum (Westwood); Distant, 1918: 137.
Eurydema pulchrum (Westwood); Hoffmann, 1932: 553, 561, 563.
Eurydema pulchrum (Westwood); Ahmad *et al.*, 1974: 47.

This species has been described in detail by Distant (1902).

Material examined. 8 ♀, 8 ♂, INDIA: Uttar Pradesh, Aligarh, University Botanical garden, on *Raphanus sativus* Linn., 20.vi.1976 (M. Nayyar Azim); 2 ♀, on *Brassica oleracea* Linn., 4.iv.1977, rest of data same as above.

IARI, New Delhi collection: 1 ♂, Uttar Pradesh, Mussoorie, on turnip leaves, 24.vi.1940 (H. S. Pruthi Coll., R-8111); 1 ♀, Bihar, Pusa, on weed, 27.iii.1933 (W. K. Wesley Coll.), *Eurydema pulchrum* (Westwood) det. Sucheta; 1 ♀, Trichinopolly, on Paddy (Baldev Coll.),

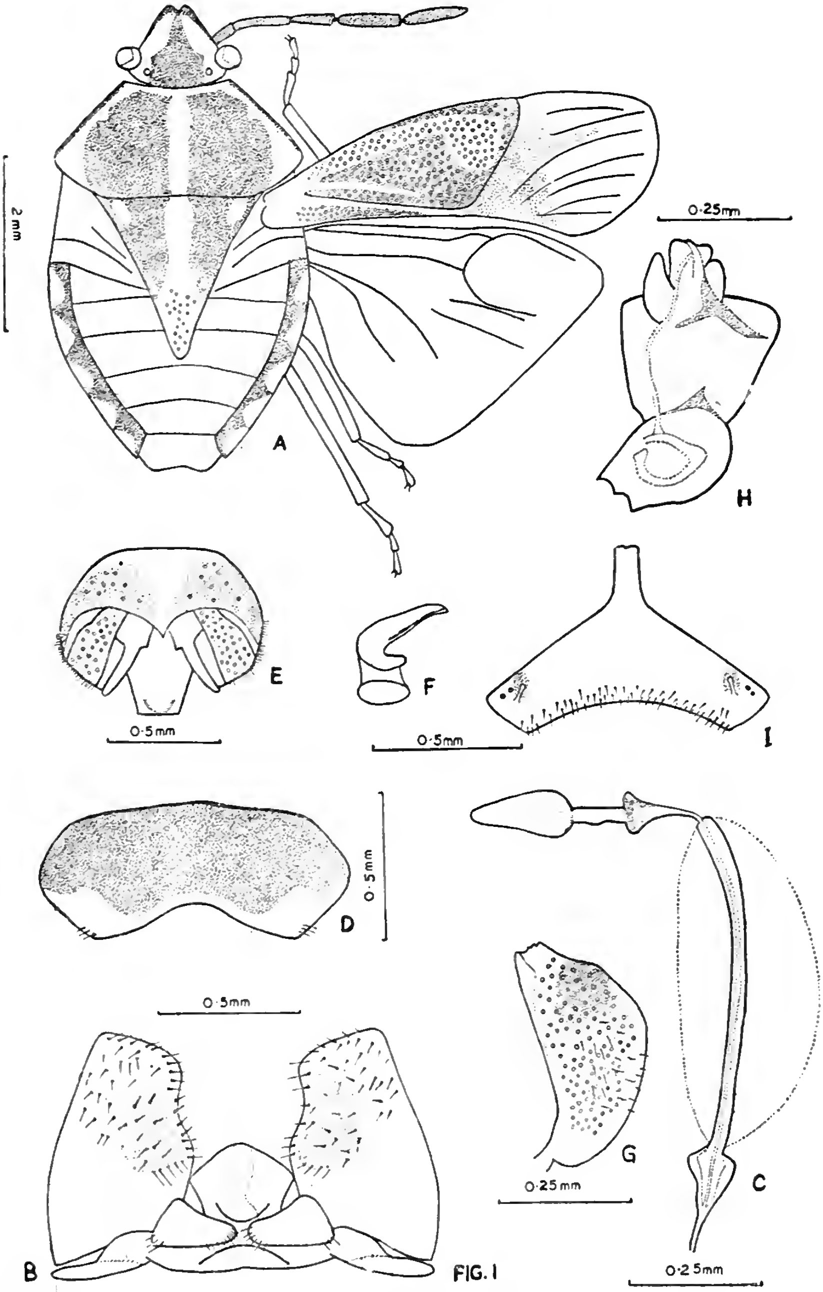

Fig. 1. A-I. *Bagrada picta* (Fabricius), ♀, ♂.
(A). Entire body, ♀; (B). External genitalia, ♀; (C). Spermatheca, ♀; (D). Last abdominal tergum, ♀; (E). Pygophore, ♂; (F). Clasper, ♂; (G). Pseudoclasper, ♂; (H). Aedeagus, ♂; (I). Subgenital plate, ♂.

Eurydema pulchrum (Westwood) det. Sucheta; 1 ♀, Baluchistan, May 1932 (C. K. Samuel Coll.), *Eurydema pulchrum* (Westwood) det. Sucheta; 1 ♂, U.P. Mussoorie, on turnip leaves, 24.vi.1940 (H. S. Pruthi Coll., R-8110), *Eurydema pulchrum* (Westwood) det. M. Bose.

Eurydema festivum (Linnaeus)

Cimex festivum Linnaeus, 1767: 723.

Eurydema festivum (Linnaeus); Reuter, 1884: 68.

Eurydema festivum (Linnaeus); Distant, 1902: 191.

Eurydema festivum (Linnaeus); Royer, 1923: 250.

Eurydema festivum (Linnaeus); Hoffmann, 1932: 553.

Eurydema festivum (Linnaeus); Kupka, 1944: 128.

This species has been described in detail by Distant (1902).

Material examined. IARI, New Delhi Collection: 1 ♂, Afghanistan, Doaba, on Carrot flowers, 14.viii.1939 (T. Ahmad Coll., R-8128); 1 ♀, Afghanistan, Kandahar, on apricot leaves, 22.vii.1939 (T. Ahmad Coll. R-8127), *Eurydema festivum* (Linn.) det. M. Bose; 1 ♂, Afghanistan, Doaba, on carrot flowers, 14.viii. 1939 (T. Ahmad Coll., R-8121), *Eurydema festivum* (Linn.) det. M. Bose, 1942; 1 ♂, Afghanistan, on *Iporhea doaba*, 14.vii.1939 (T. Ahmad Coll., R-8118), *Eurydema Festivum* (Linn.) det. B. Uvarov, 1940.

Eurydema lituriferum (Walker)

Strachia lituriferum Walker, 1867: 326.

Eurydema vicarium Horvath, 1889: 32.

Eurydema lituriferum (Walker); Distant, 1902: 191.

Eurydema lituriferum (Walker); China, 1925: 454.

This species has been described in detail by Distant (1902).

Material examined. IARI, New Delhi Collection: 1 ♀, Uttar Pradesh, Mussoorie, on turnip leaves, 24.vi.1940, (H. S. Pruthi Coll., R-8115).

4. Genus *Stenozygum* Fieber

Stenozygum Fieber, 1861: 345.

Type-species: *Stenozygum variegatum* Fieber, 1861 (=*Stenozygum coloratum* Fieber).

Head impunctate and distinctly wider than long; juga dilated apically, lateral margins reflexed and slightly sinuate before eyes; rostrum extending beyond middle coxae, bucculae as long as first rostral segment; antennae 5-segmented, first segment not reaching apex of head, second shorter than third; pronotum with anterior and anterolateral margins reflexed, humeral angles obtuse with a distinct impressed transverse line across humeral angles; scutellum well developed, narrowing apically; mesosternum with a longitudinal carina medially; metasternal scent gland ostiole, peritreme and evaporatoria indistinct; abdominal venter unsulcated and unarmed at base.

Some additional generic characters are suggested which are as follows: Female genitalia: external plates (fig. 2L), first gonocoxae quadrate, apical angles directed laterally, paratergites 8th triangular, 9th oblong; spermatheca (fig. 2M), proximal part of sclerotised tube broad and bulbous, bulb oblong without outgrowths, apical duct moderately long and uncoiled, proximal flange not much prominent.

Recently, Ghauri (1972) proposed a subgenus *Setozygum* under *Stenozygum* for the species *Stenozygum* (*Stenozygum*) *pseudospeciosum* Ghauri. He separated *Setozygum* from *Stenozygum* on the basis of its having ampliated juga, enclosing tylus, length of second antennal segment and setigerous superior process of the pygophore.

We uphold Ghauri (1972) in dividing the genus *Stenozygum* Fieber into two subgenera:

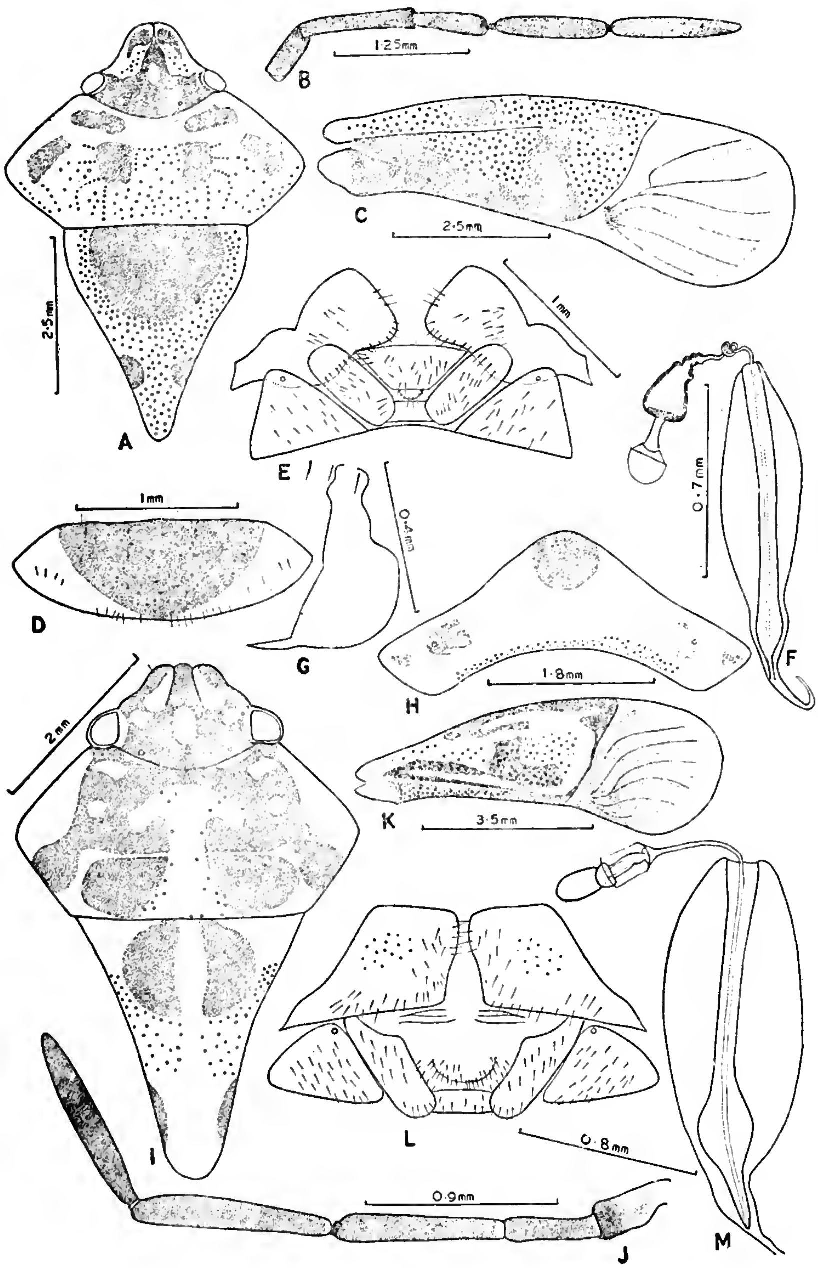

FIG. 2

Fig. 2 A-H. *Eurydema pulchrum* (Westwood), ♀, ♂.
(A). Head and thorax in dorsal view, ♀; (B). Antenna, ♀; (C) Hemelytra, ♀; (D). Last abdominal tergum, ♀; (E). External genitalia, ♀; (F). Spermatheca, ♀; (G). Clasper, ♂; (H). Subgenital plate, ♂.

Fig. 2 I-M. *Stenozygum* (*Stenozygum*) *parspeciosum* sp. nov., ♀.
(I). Head and thorax in dorsal view, ♀; (J). Antenna, ♀; (K). Hemelytra, ♀; (L). External genitalia, ♀; (M). Spermatheca, ♀.

Stenozygum S. str. and *Setozygum* Ghauri. Further, we assigned the new species under the subgenus *Stenozygum* S. str.

Stenozygum (Stenozygum) parspeciosum
sp. nov.
(Fig. 2 I-M)

FEMALE

Head (fig. I). Dark except inner margins of juga, two circular spots anterior to ocelli and one large oblong median spot ochraceous; juga as long as tylus and separated apically; eyes reddish brown, ocelli red; space between ocellus and inner orbital margin about one-fourth the inter-ocellar space. Rostrum yellowish brown except the apical segment dark, extending upto hind coxae; segments I, II, III and IV, 0.59, 0.79, 0.41 and 0.41 mm in length respectively. Antennae dark; segments I, II, III, IV and V, 0.42, 0.45, 0.85, 0.91 and 0.9 mm in length respectively.

Thorax. Pronotum dark except anterolateral margins, broad anchor-shaped spot medially and six small spots ochraceous, anterior margin concave, anterolateral margins straight and reflexed, humeral angles obtuse, maximum width about two and a half times its median length; scutellum yellowish except two basal and two subapical spots black. Hemelytra with corium sparsely punctate, spotted with yellow and dark patches as shown in fig. K, membrane infuscated except apical border hyaline, extending slightly beyond apex of abdomen. Legs: Coxae, femora with inner surfaces, tibiae with outer and inner surfaces and second tarsal segment yellowish, remaining dark.

Abdomen. Dorsum orange yellow except connexivum with yellow and dark bands, venter yellowish with double series of dark spots. Female genitalia as in generic description and as shown in figs.

Body length: 7.5 mm.

Holotype ♀. INDIA: Uttar Pradesh, Aligarh, University Botanical garden, on *Brassica compestris* Linn., 20.vii.1977 (M. Nayyar Azim)

Paratype. ♀, same data as holotype.

Material deposited in the Zoological Museum, Aligarh Muslim University, Aligarh, India.

The new species is closely related to *Stenozygum speciosum* (Dallas), but differs from it by having rostrum reaching upto hind coxae, head with five luteous spots; pronotum with anchor-shaped patch medially, rostral segments I-III yellowish.

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BREEDING HABITS AND ASSOCIATED PHENOMENA IN SOME INDIAN BATS[1]

PART XI — *MINIOPTERUS SCHREIBERSII FULIGINOSUS* (HODGSON) — VESPERTILIONIDAE

A. GOPALAKRISHNA[2], A. T. VARUTE[3], V. M. SAPKAL[2], A. R. UNUNE[3] AND G. C. CHARI[2]

Miniopterus schreibersii fuliginosus has a strict reproductive periodicity at Mahabaleshwar in Western Ghats, India. All adult females in the colony copulate in the second and the third weeks of February and conceive immediately. All deliveries in the colony occur between the 15th and 25th June. Gestation period is about 120 to 125 days. Ovulation as a rule takes place from the left ovary and the egg develops in the left Fallopian tube into a morula which quickly passes through the left uterine cornu and undergoes further development and implantation in the right cornu. The right ovary releases the ovum in very rare exceptional cases, and the embryo implants in the right uterus. The left uterus never carries the conceptus. There is community suckling of the young ones. The young ones grow rapidly during the suckling period and reach nearly the adult size by the time they are weaned. While the sex ratio is even during juvenile life, there is a female dominant uneven sex ratio in the adult stage.

INTRODUCTION

Miniopterus, with its various species and subspecies, has a wide distribution in the Old World and occurs in Europe, India, Africa, Australia and many islands in South East Pacific. The breeding habits of *Miniopterus australis* from New Hebrides (Baker & Bird 1936), New South Wales (Dwyer 1968), Borneo (Medway 1971) and from South Australia (Richardson 1977) and of *Miniopterus schreibersii* from France (Courrier 1927, Brosset 1962), New South Wales (Dwyer 1963) and South Australia (Richardson 1977) have been studied in some detail. A perusal of the literature on the breeding habits of *Miniopterus schreibersii* reveals that this species and its subspecies not only exhibit some very unusual features, but their breeding pattern varies considerably in different geographical regions. Since details concerning the reproduction of the Indian subspecies, *Miniopterus schreibersii fuliginosus*, are not known except for a casual reference to the occurence of pregnant females in the colony during certain months (Brosset 1962) while reporting on some aspects of the ecology of this species, it was felt that a detailed study of the reproduction of this bat would yield very useful data.

The present work, which involved constant examination of the colony of *Miniopterus schreibersii fuliginosus* for nearly four years and a half, was a joint effort by two groups of workers, one from the Institute of Science, Nagpur and the other from the Shivaji University, Kolhapur. The two groups have worked in close collaboration and have made volu-

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TABLE 1

SUMMARY OF COLLECTION DIARY

Date	Males				Females						Grand Total
	Immature		Adult	Total	Immature		Adult			Total	
	Attached	Free			Attached	Free	Non-pregnant	Pregnant	Lactating		
1	2	3	4	5	6	7	8	9	10	11	12
13-1-1976	–	2	8	10	–	–	15	–	–	15	25
26-1-1978	–	1	1	2	–	–	3	–	–	3	5
30-1-1978	–	1	3	4	–	–	12	–	–	12	16
4-2-1978	–	2	14	16	–	–	25	–	–	25	41
8-2-1976	–	2	5	7	–	–	13	–	–	13	20
8-2-1978	–	4	10	14	–	–	18	–	–	18	32
11-2-1978	–	–	2	2	–	–	14	–	–	14	16
13-2-1980	–	6	14	20	–	–	14	–	–	14	34
15-2-1978	–	2	7	9	–	–	21	–	–	21	30
17-2-1978	–	4	9	13	–	–	31	4	–	35	48
19-2-1978	–	3	6	9	–	–	15	3	–	18	27
21-2-1978	–	1	5	6	–	–	8	10	–	18	24
23-2-1978	–	2	8	10	–	–	1	16	–	17	27
24-2-1976	–	3	5	8	–	–	1	11	–	12	20
1-3-1978	–	2	3	5	–	–	–	11	–	11	16
4-3-1978	–	1	1	2	–	–	–	4	–	4	6
6-3-1978	–	5	12	17	–	–	4	25	–	29	46
7-3-1976	–	2	7	9	–	–	2	12	–	14	23
9-3-1978	–	4	12	16	–	–	–	21	–	21	37
14-3-1978	–	6	9	15	–	–	2	19	–	21	36
16-3-1978	–	2	11	13	–	–	4	16	–	20	33
18-3-1976	–	3	8	11	–	–	4	12	–	16	27
19-3-1978	–	9	26	35	–	–	2	40	–	42	77
23-3-1978	–	5	10	15	–	–	4	18	–	22	37
26-3-1978	–	2	17	19	–	–	–	21	–	21	40
2-4-1978	–	3	12	15	–	–	9	13	–	22	37
9-4-1978	–	5	17	22	–	–	–	40	–	40	62
14-4-1976	–	3	11	14	–	–	5	10	–	15	29
23-4-1976	–	4	9	13	–	–	4	9	–	13	26
24-4-1978	–	5	13	18	–	–	1	23	–	24	42
1-5-1978	–	3	9	12	–	–	4	11	–	15	27
7-5-1976	–	3	8	11	–	–	–	15	–	15	26
7-5-1978	–	4	8	12	–	–	1	20	–	21	33
13-5-1978	–	2	11	13	–	–	3	19	–	22	35
19-5-1978	–	3	10	13	–	–	1	24	–	25	38
20-5-1976	–	3	10	13	–	–	4	16	–	20	33
27-5-1978	–	3	6	9	–	–	–	15	–	15	24
1-6-1975	–	1	5	6	–	–	3	27	–	30	36

5-6-1978	–	2	12	14	–	–	1	20	–	21	35
16-6-1976	2	1	1	4	2	–	1	1	4	8	12
18-6-1979	3	2	14	19	1	–	1	31	4	37	56
19-6-1977	–	3	16	19	–	–	–	8	18	26	45
22-6-1976	2	3	1	6	1	–	2	3	3	9	15
14-7-1976	–	5	1	6	–	2	3	–	3	8	14
21-7-1976	–	4	1	5	–	1	3	–	3	7	12
25-7-1975	–	14	22	36	–	2	8	–	48	58	94
1-8-1975	–	19	11	30	–	5	20	–	18	43	73
9-8-1976	–	4	1	5	–	1	4	–	3	8	13
24-8-1975	–	5	11	16	–	4	18	–	7	29	45
26-8-1975	–	9	14	23	–	4	23	–	5	32	55
27-8-1976	–	3	2	5	–	1	5	–	3	9	14
28-8-1975	–	8	13	21	–	2	13	–	6	21	42
12-9-1976	–	4	3	7	–	–	3	–	1	4	11
14-9-1975	–	16	18	34	–	8	36	–	36	80	114
19-9-1975	–	7	31	38	–	6	41	–	30	77	115
23-9-1976	–	2	6	8	–	1	3	–	–	4	12
14-10-1976	–	4	10	14	–	–	10	–	–	10	24
24-10-1976	–	11	2	13	–	–	9	–	–	9	22
27-10-1975	–	32	90	122	–	21	92	–	–	113	235
6-11-1978	–	3	8	11	–	–	13	–	–	13	24
15-11-1975	–	4	11	15	–	–	21	–	–	21	36
15-11-1976	–	4	9	13	–	–	20	–	–	20	33
27-11-1976	–	3	9	12	–	–	18	–	–	18	30
28-11-1978	–	3	5	8	–	–	12	–	–	12	20
2-12-1978	–	1	8	9	–	–	10	–	–	10	19
13-12-1976	–	4	9	13	–	–	17	–	–	17	30
19-12-1975	–	4	9	13	–	–	15	–	–	15	28
22-12-1975	–	–	5	5	–	–	13	–	–	13	18
22-12-1976	–	2	11	13	–	–	17	–	–	17	30
Total	7	302	706	1015	4	58	700	548	192	1502	2517

minous notes on various aspects of the biology of this species. The present report embodies observations on the breeding habits and associated phenomena of this bat.

Material and Methods

Although many colonies of bats of this species were examined at frequent intervals and specimens were collected from several colonies, all the specimens for the present report were collected from the Robbers' cave near Mahabaleshwar in Western Ghats where a very large colony of about 200,000 specimens is present. Specimens were collected at random at frequent intervals between 1st June 1975 and 23rd February 1980. Adult and immature animals of both sexes were present in the colony throughout the year thereby indicating that there is no seasonal or sexual segregation of the specimens. The specimens were killed by chloroform and their body weights were recorded immediately. After recording the condition of the external genitalia in each specimen and the character of the mammary glands and nipples in the females, the genital

organs and accessory reproductive structures were dissected out and fixed either in Bouin's fixative or in 10% neutral formalin. Serial sections of the tissues were cut after following the usual procedure and examined after staining with Ehrlich's haematoxylin and eosin.

TABLE 2

MONTHWISE COLLECTION OF SPECIMENS

Month	Males	Females	Total
January	16(34.8%)	30(65.2%)	46
February	114(35.7%)	205(64.3%)	319
March	157(41.5%)	221(58.5%)	378
April	82(41.8%)	114(58.2%)	196
May	83(38.4%)	133(61.6%)	216
June	68(34.2%)	131(65.8%)	199
July	47(39.2%)	73(60.8%)	120
August	100(41.3%)	142(58.7%)	242
September	87(34.5%)	165(65.5%)	252
October	149(53.0%)	132(47.0%)	281
November	59(41.3%)	84(58.7%)	143
December	53(42.4%)	72(57.6%)	125
Total	1015(40.3%)	1502(59.7%)	2517

A detailed collection diary was maintained. Tables 1 and 2 give the summary of the collection diary and monthwise collection of specimens respectively.

OBSERVATIONS

1. GENERAL REMARKS ON *Miniopterus schreibersii fuliginosus*

Brosset (1962) gave an excellent description of the Robbers' cave with a brief account of the ecology of *Miniopterus schreibersii fuliginosus* inhabiting it. According to Brosset (1962) this is the largest colony of *Miniopterus schreibersii* in the world. The colony in the Robbers' cave is the 'mother' colony and there are several 'subsidiary' colonies within a radius of about 100 km. The population of the bats in the 'subsidiary' colonies varies from a few hundreds to a few thousands during different months of the year. It is very likely that a small number of these bats migrate periodically between the 'mother' and the 'subsidiary' colonies. It is impossible to determine the minor seasonal variations in the population of the specimens in the 'mother' colony since it is extremely thickly populated throughout the year. Since the present report concerns only the specimens from the Robbers' cave at Mahabaleshwar, details regarding the composition of the 'subsidiary' colonies have not been incorporated in the present report.

The mother carries the new born young only for a day or two after which the sucklings in the colony are placed in groups of about a hundred or more in each group. There are several such groups of sucklings in the colony during June, July and August. Mothers in lactation visit these groups periodically and give suck to the young on a community basis. During these months one can pick up 40 to 50 sucklings from these huddled groups with ones hand. The sucklings do not leave the groups until they are able to fly. Hence, while grown up animals were collected while they were in flight with the help of butterfly nets or with a large mist net, the sucklings were picked up at random, a few at a time, from the groups within the niches in the walls of the cave.

The Robbers' cave also contained a small number of specimens of *Rousettus leschenaulti* which remain mostly near the entrance of the cave. *Miniopterus schreibersii fuliginosus* occupies not only the regions near the entrance of the cave but the deeper parts of the cave. The deeper regions of the cave are almost exclusively occupied by *Miniopterus schreibersii fuliginosus.*

2. MORPHOLOGY OF THE FEMALE REPRODUCTIVE ORGANS

Although the general construction of the female genitalia is similar to that of all other microchiropteran bats (except the phyllostomids) in having a bicornuate uterus, there is a marked bilateral asymmetry of the uterine cornua in *Miniopterus schreibersii fuliginosus*, the right cornu being considerably longer and thicker than the left. Even in the juvenile animals the right uterine cornu is distinctly larger than the left. In the non-pregnant adult animals the right cornu is 5.5 mm long and 0.8 mm thick while the left cornu is 2.4 mm long and 0.6 mm thick. The lumina of the uterine cornua become broadly confluent at their caudal ends and a common cervical canal opens into the vagina at the tip of a short cervix. The vagina is 7.8 mm long and opens by a transverse slit-like opening.

The ovaries are enclosed in a complete bursa, and the Fallopian tubes arise from the postero-median aspect of the bursa, curves towards the lateral side after passing along the cranial margin of the bursa and opens into the cranial end of the respective uterine cornu.

The mammary glands are pectoral in position and have each a laterally directed nipple, which becomes enlarged during the first lactation and remains at nearly the same size throughout the rest of the life of the animal. In the immature females the mammary nipples are either not recognizable or are so inconspicuous as to be not visible by superficial examination since they are hidden in a mass of fur. The size of the mammary nipples, therefore, can be taken as a valid criterion to determine the sexual maturity or otherwise of the females. The females experiencing their first pregnancy can be identified only after dissection of the genital organs which contain an embryo. The mammary nipples in these animals are inconspicuous during early stages of pregnancy, and enlarge slightly during the second half of gestation.

3. NUMBER OF YOUNG AND THE SYMMETRY OF THE FEMALE GENITALIA

One of the most outstanding features revealed by the present study is the unique physiological bilateral asymmetry of the female genital organs of this bat. During each cycle a single ovum is released as a rule from the left ovary, and this undergoes fertilization in the left Fallopian tube. The egg develops into a morula while still in the Fallopian tube and, after passing quickly through the left uterine cornu, reaches the right cornu. The embryo implants in the middle of the length of the right uterine cornu and undergoes further development. Altogether 545 pregnant females were collected, and in every specimen, which had post-implantation stages of development, the conceptus was carried in the right uterine cornu. Between 16th and 22nd June 29 specimens had undergone parturition, and in each of these cases the right uterine cornu had carried the foetus as evidenced by the fact that the right uterine cornu was still in the post-partum condition. The results of the microscopic examination of the ovaries and the female genital tract have been already reported (Gopalakrishna *et al.* 1981). Only pertinent details are mentioned briefly here. A corpus luteum was present in the left ovary in all but four specimens out of 285 specimens examined microscopically. In the four exceptional cases the corpus luteum was present in the right ovary. While many specimens had unimplanted embryos in the left Fallopian tube and the left uterine cornu, there was not a single specimen with an implanted embryo in the left uterine cornu.

From the facts mentioned above it is evident that *Miniopterus schreibersii fuliginosus* exhibits a very unique type of physiological asymmetry of the female genitalia. While the left ovary as a rule is functional in releasing the ovum, pregnancy is invariably carried in the right uterine cornu. Evidently the embryo undergoes transuterine migration from the left to the right side. Even in the exceptional cases, in which ovulation occurs from the right ovary, pregnancy is carried in the right uterine cornu.

4. BREEDING HABITS

The examination of Table 1 reveals that females carrying unmistakable pregnancy as evidenced by the presence of a swollen uterine cornu were available in the colony from 1st March until 22nd June. Pregnant females were not available during the other months of the year. Evidently, *Miniopterus schreibersii fuliginosus* has a sharply defined annual reproductive cycle. Microscopic examination of the female genital organs of the specimens revealed the following facts. No female had undergone copulation until 11th February. Eight of the 14 female specimens collected on 11th February and 18 of the 21 specimens collected on 15th February had spermatozoa in the uterus and Fallopian tubes. But none had undergone ovulation. Of the 35 specimens collected on 17th February 24 had spermatozoa in the uterus and Fallopian tubes and four had ova undergoing fertilization. From this date onwards there was progressively a greater proportion of adult females which had undergone copulation and had early embryos than those which had not received spermatozoa. All adult females collected on 23rd February had eggs in early cleavage or early morulae. These facts indicate that all adult females in the colony conceive in a sharply defined period between 17th February and 23rd February. Adult females were carrying progressively more advanced conceptuses after this date until 16th June when a female carrying a young at her breast was collected early in the morning. The young one, which was attached to the breast of the mother, still had a dried up umbilical cord indicating thereby that it must have been delivered not more than a day before. On the same day later in the evening three more specimens carrying young ones at the breast were collected and the young ones had umbilical stumps. These must have been delivered in the morning of the 16th. More females in the colony had delivered their young during the following dates. Three pregnant females collected on 22nd June had full term foetuses, which, judging from their size and weight, would have been delivered in a couple of days more. Evidently all deliveries in the colony occur within a short period between 15th June and 25th June. The above data also indicates that pregnancy lasts for about 120 to 125 days calculating from 17th February (when ovulation was first noticed) to 15th June (when first delivery occurred) and allowing a couple of days margin on either side.

5. GROWTH AND MATURITY

During the season of pregnancy, that is between the middle of February to the third week of June, there were also a few non-pregnant females and sexually immature males (as revealed by the size and histological nature of the testis) in the colony (Table 1). Since there is a single breeding cycle in the year for this animal, and since deliveries take place during the third week of June, it is evident that the immature specimens obtained during the breeding season must have been born at least in the previous year in June. This would

mean that sexual maturity is not attained by individuals of either sex within the year of birth, and in the case of the females not until they are at least 20 months of age — from the middle of June, when they are delivered, to the middle of February of the year after next. Microscopic examination of the testis revealed that vigorous spermatogenctic activity occurs in the testes of animals collected on 13 January. Apparently, the males reach sexual maturity at the age of about 19 months — a month less than the time taken by the females to attain sexual maturity.

The new born young one weighs 3 gm (± 0.2 gms) and they grow rapidly during the sucking period which extends to about two months as evidenced by the fact that females in lactation were available until the middle of August. By the time the young are weaned they attain nearly the adult size. Immature specimens collected on 14th October and onwards could not be distinguished from the other animals in the colony on the basis of the size of the body. However, the weight of the testis in the male and the histological structure of the ovary and the genital tract of the female distinguish the animals in the colony into three distinct categories, namely the specimens born in the year, the immature specimens born a year before and adult specimens.

6. Sex ratio

Among 2517 specimens collected during about four years and a half 1502 were females and 1015 were males giving an uneven sex ratio of approximately 59.7% females and 40.3% males in the colony (Tables 1 and 2). The young ones are carried by the mothers only for a day or two, and after that the sucklings are placed in groups of a hundred or two hundred young ones in each group and they are suckled by lactating mothers on a community basis. The attached young ones are too few in the collection to warrant any conclusion on the sex ratio at birth. On three occasions the sucklings were randomly picked up from their groups and examined for sex ratio. The details are as given in table 3.

Table 3

Sex ratio among sucklings

Date	No. of females	No. of males	Total
10-7-1977	35	33	68
23-7-1977	18	22	40
30-7-1977	36	25	61
Total	89	80	169

These specimens have not been included in Tables 1 and 2 since they were left behind in the colony after noting the number of females and males. These observations are very significant since they reveal that there is an almost even sex ratio during the unweaned period of life. Evidently, the very uneven female-dominant sex ratio in the colony is due to the preferential mortality of the males during the growth period.

Apart from the groups of sucklings, which were noticed until about the end of September, the young born in the year can be identified until about the end of October after which they could not be identified from the other animals in the colony on the basis of the size of the body. In the case of the males the sexually immature animals can be identified from the adult ones on the basis of the weight and the histological structure of the testis. Likewise the immature females can be identified from the mature ones during the non-breeding season on the basis of the histological structure of the ovaries and the genital organs.

However, such a histological examination could not be carried out with respect to all the animals collected. Hence, all females which were non-pregnant have been included under the column 'Non-pregnant females' in Table 1, while sexually immature males have been shown under the column 'Free immature males' in the table. Consequently, while the number of sexually mature males can be accurately known, the number of sexually immature females could not be ascertained after November until the commencement of the breeding season. Hence, the sex ratio at different periods of growth of this animal could not be determined. However, the sex-ratio as revealed by the examination of Tables 1 and 2 is valid for the colony as a whole.

It is interesting to note in Table 2 that the percentage of males is smaller than that of the females and ranges between 34 to 43 per cent during all the months except October when the males outnumber the females to a small extent. It is probable that a large number of immature males were accidentally collected on 27th October, 1976 due to which the sex ratio in the collection appears to be different from that during the other months of the year.

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NEW DESCRIPTIONS

A NEW CYPRINID FISH OF THE GENUS *DANIO* HAMILTON (PISCES: CYPRINIDAE) FROM ANDHRA PRADESH, INDIA[1]

R. P. Barman[2]

(*With a text-figure*)

A new freshwater cyprinid fish belonging to the genus *Danio* Hamilton collected from Mahbubnagar district, Andhra Pradesh, India is illustrated and described in this paper. The new species is named *Danio* (*Danio*) *menoni*. The distinguishing characters of this species from its allied species *Danio* (*Danio*) *devario* (Hamilton) have been discussed. A key to the Indian species of the subgenus *Danio* is also included.

Introduction

The daniids are mainly distributed throughout the Indian subcontinent, Thailand, Malay Peninsula, Sumatra and Yunnan in China. These small active fishes which do not grow more than 110 mm. (4.5 inches) are usually found in great abundance in suitable localities of small water courses like pools in rice-fields, ditches in the bed of hill streams, mountain rivulets and rivers. These freshwater fishes do not constitute any major fishery in Indian waters and are only of secondary value. However, taxonomically these are interesting since the extensive use of these fishes in aquarium trade has cast confusion in nomenclature, systematics and zoogeography.

Day (1889) recorded 10 species and Jayaram (1981) enumerated 17 under the genus *Danio* from the Indian subcontinent. Barman (1983, 1984a and 1984b) described three new species belonging to the genus from India and Burma. While I was working on the freshwater fish fauna of Andhra Pradesh I came across three examples of a species referable to the subgenus *Danio*. Comparison with so far known species under the genus proved it to be a hitherto undescribed species.

Measurements of the fish given in parenthesis in species description are the range of proportions and outside the parenthesis are the arithmatic mean of the range of proportions of the type specimens.

Danio (Danio) menoni sp. nov.

Material: HOLOTYPE (Fig. 1): 42 mm. SP. Reg. No. Zoological Survey of India, Calcutta, FF2282. Locality: stream near Mosampet village, Mahbubnagar district, Andhra Pradesh, India. Collector: R. P. Barman and party. Date of collection: 15.12.1984. PARATYPES: 2 exs., 40 mm.-43 mm. SL. Reg. No. Zoological Survey of India, Calcutta, FF2283. Locality, collector and date of collection same as in holotype.

Etymology: For Dr. A. G. K. Menon, Emeritus Scientist in recognition of his contributions to the fishes of the world.

[1] Accepted June 1985.

[2] Zoological Survey of India, 27, Jawaharlal Nehru Road, Calcutta-700 016.

Diagnosis:

Head length 3.90-4.00 and body depth 3.07-3.23 in standard length. Eye diameter 3.33-3.66 in head length. Least depth of caudal peduncle 1.33-1.75 in its length. Lateral line complete with 33-34 scales. Dorsal fin rays 10-11 and anal fin rays 21-22. Barbels absent. Presence of two dark spots, one at the superior margin of the gill opening and the other one at the base of caudal fin.

Fig. 1. Lateral view of the holotype of *Danio* (*Danio*) *menoni* sp. nov.

Description:

Head length 3.96 (3.90-4.00) at the most distant point on the opercular membrane, body depth 3.12 (3.07-3.23) at the commencement of pelvic fin, predorsal distance 1.49 (1.48-1.50), prepelvic distance 2.15 (2.10-2.22), preanal distance 1.50 (1.48-1.53) and length of caudal fin 3.12 (3.07-3.23) in standard length. Depth of head 1.36 (1.31-1.42) at the occiput and width of head 1.86 (1.75-2.00) in head length.. Eye diameter 3.49 (3.33-3.66) in head length, 1.55 (1.50-1.66) in interorbital width. Snout length 4.20 (4.00-4.40) in head length, 1.86 (1.80-2.00) in interorbital width. Length of the postorbital part of head is twice or slightly less that of the snout length or preorbital part of head. Cleft of mouth moderate, obliquely directed upward extending near to anterior margin of the eye. Least depth of caudal peduncle 1.52 (1.33-1.75) in its length. Barbels absent.

Scales: Lateral line complete covering 33-34. Lateral transverse scales at the pelvic fin origin 10; scales between lateral line and base of pelvic fin 2½. 18-19 predorsal and 12 circumpenduncular scales.

Fins: D.ii,8-9; A.iii,18-19; P.i,11; V.i,6; C.19.

Dorsal originates opposite or slightly behind the anal origin, considerably nearer to the base of caudal fin than to the tip of snout and extending over almost the whole length of the

TABLE 1

MEASUREMENTS (IN MM.) AND MERISTIC COUNTS OF *Danio* (*Danio*) *menoni* sp. nov.

	Holotypes	Paratypes	
Total length	55.0	53.0	57.0
Standard length	42.0	40.0	43.0
Caudal fin length	13.0	13.0	14.0
Head length	10.5	10.0	11.0
Head depth at the occiput	8.0	7.0	8.0
Head width at pre-opercular margin	6.0	5.0	6.0
Body depth at pelvic origin	13.0	13.0	14.0
Eye diameter	3.0	3.0	3.0
Interorbital width	4.5	4.5	5.0
Snout length	2.5	2.5	2.5
Predorsal distance	28.0	27.0	29.0
Prepelvic distance	20.0	18.0	20.0
Preanal distance	28.0	27.0	28.0
Length of longest dorsal fin ray	8.0	8.0	8.0
Length of longest anal fin ray	9.0	9.0	9.0
Pectoral length	15.5	15.0	16.0
Pelvic length	8.0	7.0	8.0
Caudal peduncle length	6.0	6.0	7.0
Caudal peduncle depth	4.0	4.0	4.5
Lateral line scales	34	33	34
Dorsal fin days	2/9	2/9	2/8
Anal fin rays	3/19	3/18	3/19

anal fin. Pelvic fin commences on a vertical considerably anterior to the dorsal fin. Length of the longest dorsal ray 5.20 (5.00-5.37), length of longest anal ray 4.62 (4.44-4.77), pectoral length 2.68 (2.66-2.70) and pelvic length 5.44 (5.25-5.71) in standard length. Caudal fin emarginate with equal lobes. The most conspicuous characteristic of the fins are the pectoral fins which extend almost upto the tip of pelvic fin.

Measurements and counts of this species are given in table 1.

Colour in life: Dorsal surface moderately dark and ventral and sides pale silvery. A prominent dark spot present on the superior margin of the gill opening and a second dark blotch at the base of caudal fin. A lateral dark straight line extending from the base of caudal fin to middle of opercular end and origin of dorsal fin. All fins white.

Distribution and Habitat: *Danio* (*Danio*) *menoni* is known only from a stream near Mosampet village, Mahbubnagar district, Andhra Pradesh, India which lies between approximately 16.5°-17°N latitude and 77°-78°E longitude. The holotype and paratypes were collected with cast net over muddy substratum in a quiet, semiturbid pool approximately 150 × 80 m. with a maximum depth of about 1.5 m.

Relationships:

Danio (*Danio*) *menoni* sp. nov. is closely related to *Danio* (*Danio*) *devario* (Hamilton) in head length, anal fin-rays count and in general appearance of the body. The new species can be easily separated from the latter species by a combination of characters which include absence of barbels, lateral line scale count 33-34, transverse scale count 10, circumpeduncular scale count 12, body depth relatively shorter, shorter eye diameter, dorsal fin rays less (10-11), pectoral fin relatively longer and presence of two dark spots, one on the superior margin of gill opening and the other at the base of caudal fin. These characteristics are shown and compared in table 2.

TABLE 2

COMPARISON OF *D. menoni* SP. NOV. WITH THE RELATED SPECIES

Characters	*D. devario*	*D. menoni* sp nov.
Standard length/ Body depth	2.60–2.86	3.07–3.23
Head length/Eye diameter	2.57–3.00	3.33–3.50
Lateral line scales	45–52	33–34
Transverse scales	14–15	10
Circumpeduncular scales	14–16	12
Dorsal fin rays	19–20	10–11
Standard length/ Pectoral length	4.00–4.77	2.66–2.70
Barbels	* present	absent
A dark spot present on superior margin of gill opening	absent	present

* Hamilton (1822) described *D. devario* from Indian waters without barbels and subsequent workers like Day (1889) and Hora (1934) recorded this species with no barbels. During the course of my revisionary studies on the cyprinid genus *Danio*, out of hundreds of specimens of this species examined by me from different localities of India, not a single specimen was found without a pair of posterior or maxillary barbels.

KEY TO THE INDIAN SPECIES OF THE SUBGENUS *Danio*

1. A small preorbital spinous process backwardly directed on anterior rim of the orbit present...2
   No preorbital spinous process on anterior rim of the orbit. 6
2. One or two supraorbital forwardly directed spine in addition to the preorbital spinous process on the anterior rim of the orbit........ .... *D. spinosus* Day
   No supraorbital spine. 3

3. Lateral line scales 54-56, transverse scales 15... .... *D. annandalei* Chaudhuri
   Lateral line scales not more than 53..........4
4. Lateral line scales 40-41, transverse scales 10... ....*D. assamensis* Barman
   Lateral line scales 32-37 5
5. Lateral line scales 32. Dorsal fin rays 10. One pair of posterior or maxillary barbels.......... ....*D. kakhienensis* Anderson
   Lateral line scales 35-37. Dorsal fin rays 12-13. Two pairs of barbels.........*D. aequipinnatus* (McClelland)
6. Dorsal fin rays 19-20. Lateral line scales 45-52. One pair of posterior or maxillary barbels..... ....*D. devario* (Hamilton)
   Dorsal fin rays less than 18. Lateral line scales not more than 45 7
7. Barbels absent. Dorsal fin rays 10-11. Lateral line scales 33-34 ....*D. menoni* sp. nov.
   Two pairs of barbels present 8
8. Barbels well developed, both pairs of barbels much longer than eye diameter. Lateral line scales 36-42. Lateral dark bands breaking up anteriorly to form a mottled pattern. .... *D. dangila* (Hamilton)
   Barbels not well developed, both pairs of barbels much shorter than eye diameter..........9
9. Lower lip hypertrophied forming a loose flap along the lower jaw. Lateral line scales 40-41. Anal fin rays 17-19............*D. fraseri* Hora
   Lower lip not hypertrophied, simple. Anal fin rays less than 17. 10
10. Dorsal fin rays 12-14. Literal line scales 37-38. ....*D. neilgherriensis* (Day)
    Dorsal fin rays 10. Lateral line scales 40-42.... .... *D. naganensis* Chaudhuri

ACKNOWLEDGEMENTS

I am grateful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for laboratory facilities. I am also thankful to Drs. K. C. Jayaram, Joint Director and A. G. K. Menon, Emeritus Scientist, Zoological Survey of India for their valuable suggestions. Thanks are also due to Drs. A. K. Ghosh, Deputy Director and P. K. Talwar, Deputy Director, Zoological Survey of India, Calcutta for their encouragement.

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DESCRIPTIONS OF THREE NEW SPECIES OF *SCHIZASPIDIA* WESTWOOD (HYMENOPTERA: EUCHARITIDAE) WITH A KEY AND A CHECK-LIST TO THE SPECIES OF INDIAN SUBCONTINENT[1]

T. C. NARENDRAN[2]

(*With eighteen text-figures*)

Three new species of *Schizaspidia* Westwood, viz. *S. brevifuniculata*, *S. sitarami* and *S. malabarica* are described. Key to the species of Indian subcontinent is provided. A check-list of species of *Schizaspidia* of this subcontinent is also given.

The study of Eucharitidae of Indian subcontinent was perhaps started by Westwood (1835). Since then Walker (1860), Enderlein (1912), Aiyar (1925), Clausen (1928), Mani (1935, 1942), Gahan (1940), Fernandow (1957), Mani *et al.* (1974), Hedqvist (1978), Husain and Agarwal (1983) and Narendran (*in press*) contributed to our knowledge of Eucharitidae of this region. During the course of my studies on Indian chalcid wasps I came across three distinct species of the genus *Schizaspidia* from the Malabar region. These three species neither fit to the keys of Hedqvist (1978) nor fit to the descriptions of any of the species known from the Indo-Australian regions. Apart from the descriptions of these new species I have also provided below a revised key and a check-list of the *Schizaspidia* species of Indian subcontinent.

The types of the new species described in this paper are with the author for the time being but eventually will be deposited in an International Museum.

Schizaspidia brevifuniculata sp. nov. (Figs. 1-6)

Female: Length: 2.79 mm. Head and body blackish metallic green; antennae dark brown with scape and pedicel yellowish brown; eyes greyish; coxae concolorous with thorax, femora and middle portions of tibiae brown; apices of femora, bases and apices of tibiae and tarsi pale yellow; tegulae brownish yellow; wings hyaline without any distinct infumation.

Head width subequal to thoracic width when measured from dorsal side. Frons smooth and polished with very weak striations on dorsal half as in figure 1; POL: 9; OOL: 5; tentorial pits deep. Antenna relatively short and as in figure 2. Thoracic notum characteristically sculptured as in figure 3; sculpture of mesopleuron as in figure 4. Gasteral petiole a trifle longer than hind coxa (distinctly less than 1.5 times hind coxa length), dorsal side almost smooth without distinct sculptures, sides weakly carinate; gasteral tergites smooth and shiny without distinct sculptures.

Remarks: This new species comes to the couplet number 10 of the key by Hedqvist (1978) but differs from *S. fasciatipennis* (Girault) (Girault 1928) in not having a transverse band on the forewing, in having different colour of the body (not blue-green as in *fasciatipennis*) and in having differences in the shape and size of the antennal segments. It differs from the various species of Indian subcontinent as mentioned in the key below.

Holotype ♀. INDIA: Kerala, S. Malabar, Chettiyarmad, 15.i.1984, T. C. Narendran.

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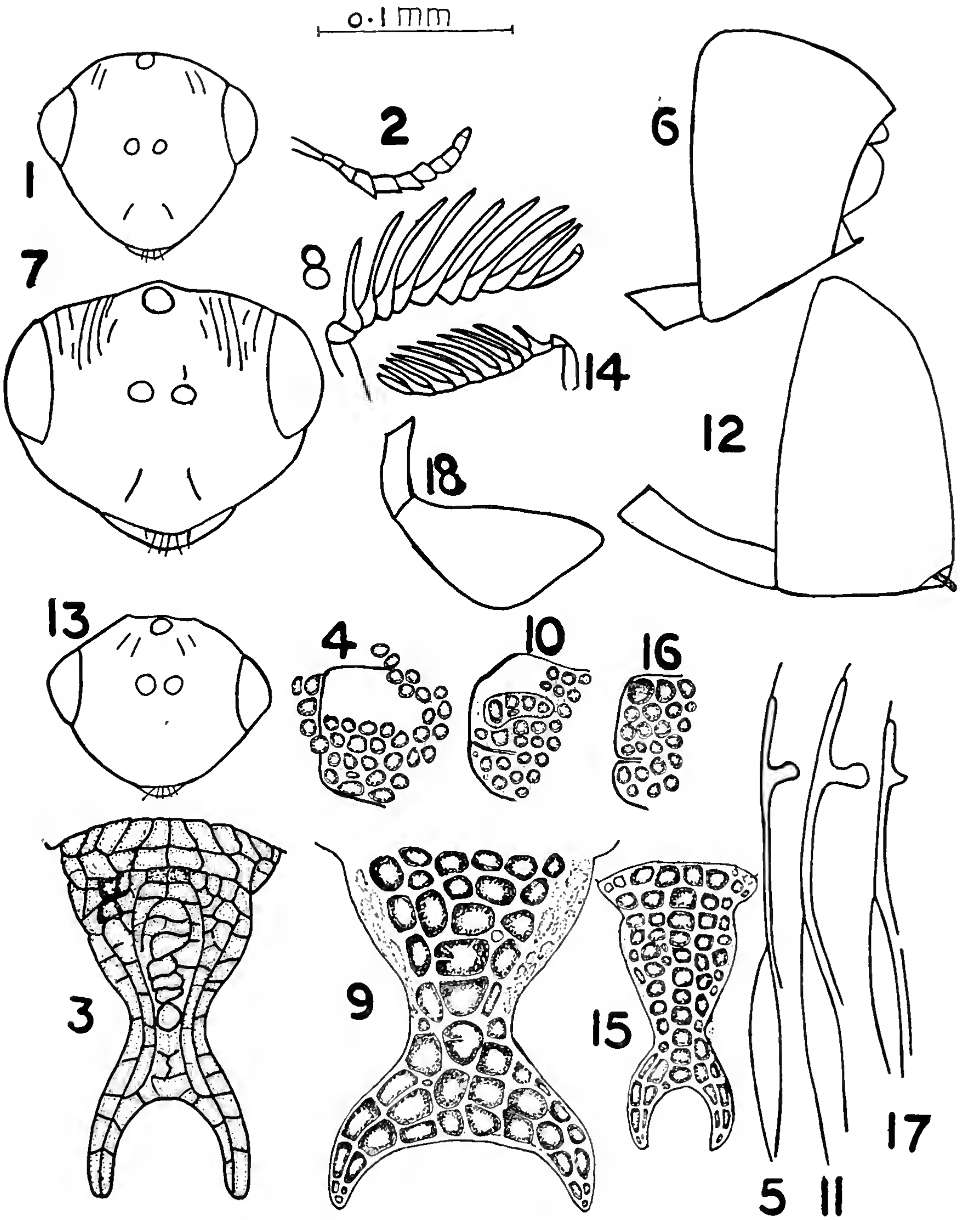

Figs. 1-6. *Schizaspidia brevifuniculata* sp. nov. ♀
1. Head, front view; 2. Antenna; 3. Scutellum; 4. Mesopleuron; 5. Forewing; 6. Gaster.

Figs. 7-12. *Schizaspidia sitarami* sp. nov. ♂
7. Head, front view; 8. Antenna; 9. Scutellum; 10. Mesopleuron; 11. Forewing; 12. Gaster.

Figs. 13-18. *Schizaspidia malabarica* sp. nov. ♂
13. Head, front view; 14. Antenna; 15. Scutellum; 16. Mesopleuron; 17. Forewing; 18. Gaster.

Schizaspidia sitarami sp. nov.
(Figs. 7-12)

Male: Length: 3.69 mm. Head and thorax greenish black; antennae blackish brown; coxae and gasteral petiole concolorous with thorax, rest of legs and gaster brownish yellow. Wings hyaline without infuscation, veins brownish.

Head width a little less than the maximum thoracic width when measured from dorsal side. Frons smooth and polished with somewhat strong striations on upper part; POL: 10; OOL: 8; tentorial pits deep. Antennae as in figure 8; thoracic sculpture of scutellum as in figure 9; mesopleura as in figure 10. Gasteral petiole a little over two times the length of hind coxa, dorsal and lateral sides distinctly punctate, sides ecarinate, ventral surface with irregular weak carinae; gasteral tergites smooth and shiny.

Remarks: This new species comes near *S. batuensis* Hedqvist (Hedqvist 1978) but differs from it in having much broader scutellar forks, in having different scutellar sculptures, and in having a number of other miner characters. From the various species of Indian Subcontinent it can be easily separated by the characters mentioned in the key of this paper.

Holotype: ♂. INDIA: Kerala, Calicut University Campus, 1.iv.1985, Narendran *et al.*

Schizaspidia malabarica sp. nov.
(Figs. 13-18)

Male: Length 2.27 mm. Head and body generally blackish green; Antennae pale brown; eyes blackish yellow; coxae blackish brown, remaining parts of legs brownish yellow; petiole blackish green; gaster yellowish brown, wings hyaline without infumation anywhere, veins pale brown.

Head from above width 35; thorax width 35 (measured from dorsal side at its maximum width); frons smooth and polished on lower half, upper half rugulose and very sparsely striate; tentorial pits deep. Sculpture on the thoracic notum as in figure 15; mesopleuron as in figure 16; gasteral petiole a trifle longer than twice the length of hind coxa, dorsal side with distinct reticulate punctures, ventral side shallowly grooved longitudinally; gasteral tergites smooth and shiny.

Remarks: This new species comes to the couplet number 11 of the key of Hedqvist (1978) but differs from the Philippine species *S. batuensis* Hedqvist in having entirely different type of scutellum; in having different type of antennae, in having different coloration of head and body and in several other features. It differs from all the other species of Indian subcontinent by the characters mentioned in the key below.

Holotype ♂. INDIA: Kerala, S. Malabar, Ramanattukara, nr. Calicut, 1.v.1983, T. C. Narendran; *Paratype*: ♂, Kerala, S. Malabar, Calicut University, 1.iv.1985, T. C. Narendran *et al.*

KEY TO SPECIES OF *Schizaspidia* WESTWOOD OF INDIAN SUBCONTINENT

(Males or Females of some species are unknown)

1. Antennae with very long branches (Fig. 14) .. .. 2 (Males)
= Antennae without long branches (Fig. 2 .... 9 (Females)
2. First flagellar segment without a tooth or branch 3
= First flagellar segment with a tooth or branch 4
3. Mesopleuron with distinct punctures and pits and without a distinct smooth area; scutellar arms short (similar to Fig. 15 or shorter) .... *S. convergens* (Walker)
= Mesopleuron smooth at extreme anterodorsal angle followed by obscure transverse striations; scutellar arms long and prominent (Fig. 24G of Mani *et al.* 1974) .... *S. sabariensis* (Mani & Dubey)

4. Flagellar segments with cylindrical branches; head and body dark metallic green in colour .... *S. travancorensis* (Mani)
= Flagellar segments with flattened branches.... 5
5. Mesopleuron rugoso-punctate without a smooth area 7
= Mesopleuron anteriorly with a more or less smooth area as in figures 4 & 10............ 6
6. Scutellum with very large and broad forkes (Fig. 9) .... *S. sitarami* sp. nov.
= Scutellum with smaller and narrower forks.... .... *S. andamanensis* (Mani)
7. Scutellum with short & broad apical branches (as in Fig. 24 of Hedqvist, 1978) .... *S. frucifera* Westwood
= Scutellum not as above.....................8
8. Gaster subglobose (Fig. 26G of Mani *et al.* 1974); Petiole smooth without any striae; forewing with a diffuse faint infumation........... .... *S. coromandelica* (Mani & Dubey)
= Gaster elogate as in figure 18; petiole not smooth but distinctly ruguso-punctate; forewing without infumation ....*S. malabarica* sp. nov.
9. Scutellar arms very short (as in Fig. 12 of Hedqvist 1978) with longitudinal striations; forewing with a transverse band from stigmal vein, extending towards posterior wing margin .... *S. frucifera* Westwood
= Scutellum not as above 10
10. Scutellum with longitudinal carinae connected by transverse carinae 11
= Scutellum with large pits, umblicately punctate (as in Fig. 25F of Mani *et al.* 1974); upper part of frons with strong striations; forewing with a distinct conspicuous infumation around the stigmal vein .... *S. sabariensis* (Mani & Dubey)
11. Scutellum with more or less longitudinal carinae with regular transverse wrinkles (as in Fig. 15 of Hedqvist 1978); gaster green; Head & body metallic yellowish green .... *S. convergens* (Walker)
= Scutellum with more or less irregular longitudinal carinae with irregular wrinkles (Fig. 3); gaster ferrugenous brown; head & body blackish metallic green ...... *S. brevifuniculata* sp. nov.

CHECK-LIST OF *Schizaspidia* SPECIES OF INDIAN SUBCONTINENT
(Invalid names are in italics)

ANDAMANENSIS (Mani, 1942) (*Kapaloides*) India: Andaman Islands.
BREVIFUNICULATA sp. nov.; India: Kerala.
CONVERGENS (Walker, 1860) (*Eucharis*) Sri Lanka (=Ceylon).
=*ceylonica* (Enderlein, 1912) (*Psygmatocera*) Sri Lanka (=Ceylon)
COROMANDELICA (Mani & Dubey, 1974) (*Kapaloides*) India: Coromandel Coast, (Tamil Nadu).
FRUCIFERA Westwood, 1835, India: Bengal.
MALABARICA sp. nov. India: Kerala.
SABARIENSIS (Mani & Dubey, 1974) (*Kapaloides*) India: Kerala, cardamom hills.
SITARAMI sp. nov. India: Kerala.
TRAVANCORENSIS (Mani, 1942) (*Kapaloides*) India: Kerala. Travancore.

The species *atkinsoni* (Mani & Dubey, 1974), *indica* (Mani, 1935), *manipurensis* (Clausen, 1928), *mysorensis* (Mani & Dubey, 1974) and *tanjorensis* (Mani & Dubey, 1974) which are all described originally under *Schizaspidia* Westwood actually belong to another genus viz. *Stibula* Spinola.

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ON A NEW SPECIES OF GENUS *HYDRONOMIDIUS* (BAGOINAE: CURCULIONIDAE) FROM INDIA[1]

H. R. Pajni and P. Kamal Tewari[2]

(*With five text-figures*)

A new species *Hydronomidius punjabensis* under the monobasic genus *Hydronomidius* has been described. The characters of the genus has been revised.

Introduction

During the course of a five year PL 480 project (1976-81), a large number of new species were procured. One among these falls under genus *Hydronomidius* which is being reported in this communication including the revised characters of the genus.

Genus *Hydronomidius* is a monobasic genus with an Indian type species, *Hydronomidius molitor* (Faust 1898). The genus *Hydronomidius* differs from the genus *Bagous*, the only other Indian genus from subfamily Bagoinae, in having anterior border of prosternum not notched and rostral canal as well as ocular lobes absent. The new species differs from other described species in several respects.

Genus *Hydronomidius* Fst.

Faust, Deutsche Ent. Zeitschr. 1898, p. 283.

Rostrum long, more or less stout, sub-arcuate; scrobes deep, oblique or straight, Antennae moderately long, inserted in middle or beyond middle or rostrum; funicle 7-segmented, segment 1 elongated, 2-7 gradually widening towards apex, segment 7 closely approximated to club; club oblong, sub-acuminate at apex. Eyes dorsolateral, rounded and prominent. Prothorax subtransverse, truncate at base as well as at apex; ocular lobes absent. Scutellum distinct. Elytra

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oblong with shoulders prominent, parallel sided upto apical one-third, narrowed beyond and rounded. Prosternum not notched at anterior border, without any rostral canal or deep depression. Abdomen with visible sternites 1 and 2 each two times as long as 3 and 4 united. Male genitalia with aedeagal apodemes twice as long as aedeagus; phallobasic apodeme slightly shorter than aedeagal apodemes; parameres united throughout their length. Female genitalia with coxites bearing tubular styli; spiculum ventrale forked at base, dilated and laterally produced at apex; spermatheca with cornu long and pointed at apex, collum and ramus undifferentiated.

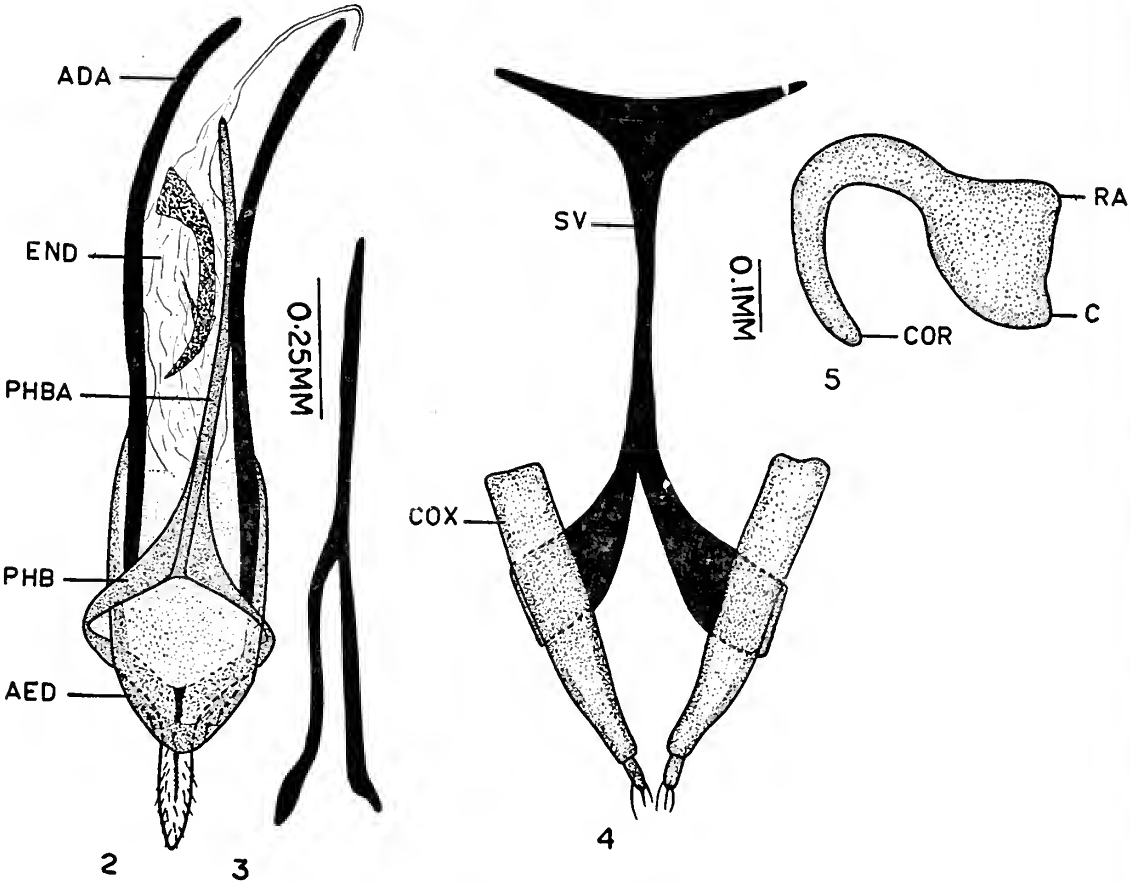
Type species: *Hydronomidius molitor* Fst.

Hydronomidius punjabensis sp. nov.
(Figs. 1-5)

Head black, convex, compactly covered with overlapping rounded scales of brown and yellow colour; frons narrower than the base of rostrum, covered with scales. Eyes black, lateral, oval in shape. Rostrum black, long, almost as long as prothorax, thick, stout, broad and subconvex above, parallel sided upto antennal insertion, somewhat dilated at apex; its surface finely punctured, with a faint raised line in the middle, closely covered with rounded scales and small silky hairs upto antennal insertion, apex shining and furnished with a few long setae; scrobes lateral, oblique, not reaching the eyes; clothed with small, yellowish scales. Antennae ferrugineous, inserted at apical one-third of rostrum; scape long, slender, clavate at apex, not touching the eyes; funicle long furnished with hairs, with segment 1 broader as well as longer than 2,2 longer than broad, 3 to 6 subequal and conical in shape, 7 longer than broad and approximate to the base of club; club small, oblong, pubescent, sub-acuminate at apex.

Pronotum somewhat as long as broad, with base as well as the apex truncate, its sides gradually diverging from base to apical one-third where it is rounded, constricted just before the apex, slightly convex just before the middle and impressed at base; its surface finely punctured and covered with overlapping scales; scales pale-yellow on the sides and brown and pale in the middle, rarely with a faintly raised line in the middle. Scutellum small, oval, covered with white scales. Thoracic sterna black, finely punctured and covered with overlapping rounded scales and a few silky setae, the scales

Fig. 1. *Hydronomidius punjabensis* sp. nov. — Male.



Figs. 2-5: *Hydronomidius punjabensis* sp. nov.
2. Male genitalia, 3. Gastral spiculum, 4. Female genitalia, 5. Spermatheca.
Abbreviations: ADA—aedeagal apodeme; AED—aedeagus; C—collum; COR—cornu; COX—coxite; END—endophallus; PHB—phallobase; PHBA—phallobasic apodeme; RA—ramus; SV—spiculum ventrale.

pale-white on the prosternum, yellowish-brown on the meso- and meta-sternum.

Elytra black, double as long as broad, oblong; shoulders prominent and rounded, somewhat impressed on the inner half, with base feebly bisinuate and apex truncate, parallel sided upto middle and then gradually narrowing to beak-like apex, slightly convex in the middle and sloping behind; its surface compactly covered with overlapping rounded scales of brown and pale-white colours; striae narrow covered with scales, each stria with a linear row of small, deep punctures; intervals broad, sub-convex, shining, finely punctured, intervals 2 and 3 with a pale-white spot approximately in the middle and some similar spots of irregular shape on the side intervals. Legs black, long, covered with yellowish-brown and pale scales; and small silky setae; femora long, laterally compressed, thickened just before

middle; tibiae long, slender, laterally compressed, with its ventral margin furnished with a row of small denticles accompanied by long setae and a strong uncus at apex; tarsi ferrugineous long, with segment 1 to 3 subequal, longer than broad, 4 almost as long as 2 and 3 taken together; claws long, simple and free. Abdominal sternites brownish-black, with rounded punctures, covered with rounded scales; with visible sternites 1 and 2 almost equally long on the sides, line separating them indistinct in the middle, both of them at a level higher than 3 proceeding segments, 3 and 4 equally long, 5 truncate at apex where it is slightly depressed, with a subapical bunch of transparent setae on each side.

Male genitalia with aedeagus small, slender, subconical in shape, with base broad and apex narrow and subacuminate, well sclerotized on lateral sides; aedeagal apodemes double as long as aedeagus; endophallus with a sickle shaped sclerotized structure. Phallobase moderately sclerotized, with phallobasic apodeme slightly shorter than aedeagal apodemes; parameres moderately long, jointed or fused throughout from base to apex, furnished with very minute setae. Gastral spiculum well sclerotized, forked with its lateral arms slightly shorter than the median arm.

Female genitalia with coxites very long, very gradually narrowing from base to apex, more sclerotized near apex; styli small, longer than broad, bearing very small setae. Spiculum ventrale forked at base, with its median arm dilated and laterally produced at apex, with lateral arms short and broad; Spermatheca with cornu long, curved and subrounded at apex; collum and ramus fused to form a swollen structure but their openings well marked.

Measurements:

Length of body	:	6.00-6.30 mm
Length of rostrum	:	1.00-1.10 mm
Breadth of body	:	1.90-2.10 mm
Breadth of rostrum	:	0.45-0.50 mm

Specimens examined:

Holotype ♂, INDIA: Punjab. Amloh, from tube light, 10.viii.1979.

Paratypes, 10 ♂♂, 6 ♀♀, data same as for holotype; 5 ♂♂, 2 ♀♀, India: Chandigarh from tube light, 5.vii.1978.

Material deposited in the Entomology section, Department of Zoology, Panjab University, Chandigarh.

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We thank the U.S. Department of Agriculture and I.C.A.R. for financing a 5 year project on Indian Curculionidae and arranging a trip to the European Museums for the senior author. The research facilities provided by the Chairman, Department of Zoology, Panjab University, Chandigarh are duly acknowledged.

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A NEW SPECIES OF THE GENUS *CHLORISSA* STEPHENS FROM NORTH INDIA (GEOMETRINAE: GEOMETRIDAE: LEPIDOPTERA)[1]

H. S. Rose and Devinder[2]

(*With five text-figures*)

The species *Chlorissa patialaensis* sp nov. is congeneric with other species of the genus *Chlorissa* Stephens, so far known. The species is described in detail, including the structure of its internal as well as external reproductive organs.

Introduction

During collection surveys for Geometrid moths from Patiala (Punjab) and its surrounding areas, a sample of six specimens was collected and the same is referable to the genus *Chlorissa* Stephens, recently revised by Pajni and Walia (1984). The genus *Chlorissa* is so far represented by four Indian species namely *discessa* (Walker), *punctifimbria* (Warren), *pretiosaria* (Staudinger) and *albifasciata* Pajni and Walia. The species under reference is clearly congeneric with *Chlorissa* sp. (Pajni and Walia, loc. cit.) but the specific status of the species could not be identified from sources at hand. Accordingly, the species is described under the genus *Chlorissa* as a new species.

Chlorissa patialaensis sp. nov.

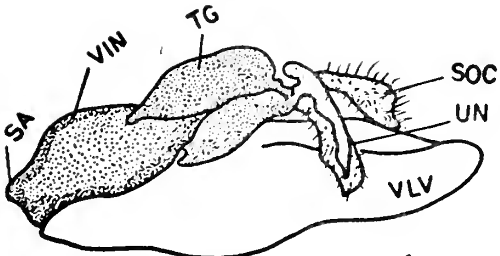
(Figs. 1-5)

Head, thorax and abdomen smoothly scaled, covered with small dull green scales dorsally, white ventrally; both pairs of wings with ground colour dull green, with whitish appearance on ventral surface, without any markings; forewing with discal cell about two-third the length of the wing, vein R_1 free, arising from anterior angle of cell, veins R_2, R_3, R_4 and R_5 with a common stalk, M_1 briefly stalked with $R_{2+3+4+5}$, M_3 and Cu_1 from lower angle of cell, termen oblique; hind wing with discal cell very short, veins R_5 and M_1 stalked from upper angles of cell, M_2 from the middle of discocellulars, M_3 and Cu_1, shortly stalked, Cu_1, from before posterior angle of cell, termen slightly produced outwardly.

Uncus moderately long, uniformly cylindric, produced into a fine point, completely bare distally; a pair of symmetrical socii present, each socii semimembranous, more or less spoon shaped, sparsely setosed with five-setae; gnathos missing; tegumen moderately sclerotized; vinculum more or less v-shaped; saccus rudimentary; valve long, costa well differentiated, weakly sclerotized, sacculus broadly inflated, comparatively better sclerotized, with a small thumb like projection on its inner part, harpe present, more or less globular, its inner edges produced into five unequal sized denticles; aedeagus long, narrower in the anterior region and broad in the posterior region, vesica

[1] Accepted April 1985.

[2] Department of Zoology, Punjabi University, Patiala-147 002, Punjab, India.



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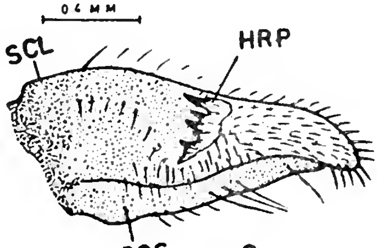

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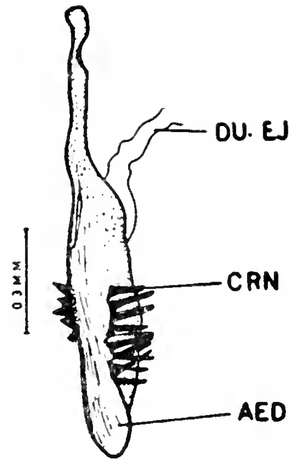

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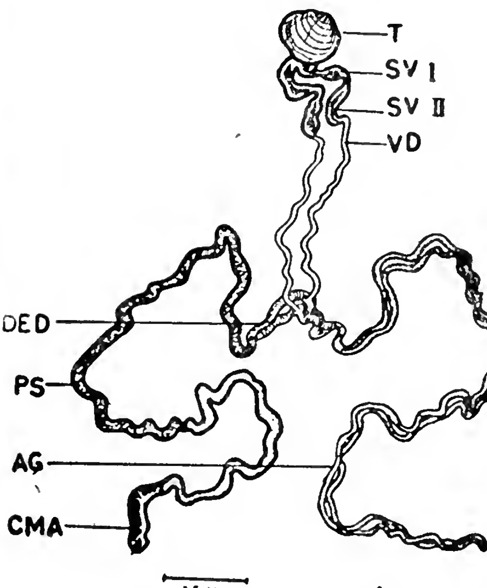

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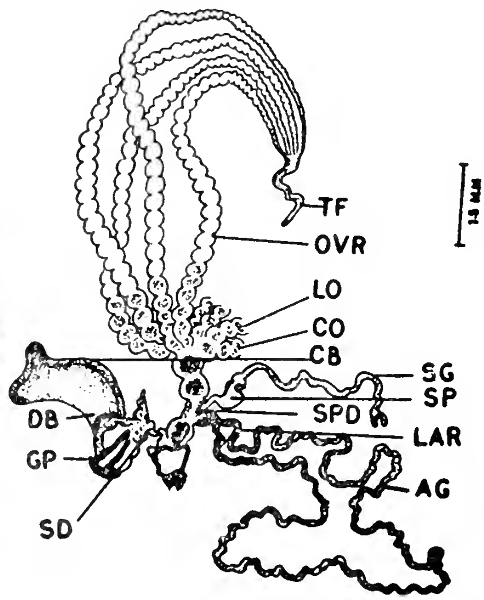

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Fig. 1. Main part of the male external genitalia of *Chlorissa patialaensis* sp. nov.
Fig. 2. Valve (detached) of *C. patialaensis* sp. nov.
Fig. 3. Aedeagus of *C. patialaensis* sp. nov.
Fig. 4. Male internal reproductive organs of *C. patialaensis* sp. nov.
Fig. 5. Female internal reproductive organs of *C. patialaensis* sp. nov.
AED: Aedeagus; AG: Accessory gland; CB: Corpus bursae; CMA: Cuticular Muscular area; CO: Common oviduct; COS: Costa; CRN: Cornutus; DB: Ductus bursae; DED: Ductus ejaculatorious duplex; DU. ED: Ejaculatory duct; GP: Genital plate; HRP: Harpe; JX: Juxta; LAR: Lateral accessory reservoir; LO: Lateral oviduct; OVM: Ovum; OVR: Ovariole; PS: Primary segment; SC: Saccus; SCL: Sacculus; SD: Seminal duct; SG: Spermathecal gland; SOC: Socii; SP: Spermatheca; SPD: Spermathecal duct; SVI: Seminal veside-I; SVII: Seminalvesicle-II; T: Testes; TG: Tegumen; TF: Terminal filament; UN: Uncus; VD: Vasa deferentia; VIN: Vinculum.

well defined, beset with five small denticles besides a group of eleven finger like spinulose processes, representing cornuti.

Testes creamish yellow, circular 0.65 mm. in diameter, jelly like; seminal vesicle I: 0.85 mm long, creamish white, cylindrical, sclerotized, seminal vesicle II: 0.7 mm. long, creamish white, slightly curved, sclerotized, both seminal vesicles separated by a distinct duct; vasa deferentia 2.9 mm. long, white, transparent, open one third towards the side of the ejaculatorious duplex, 1.45 mm long, curved, arms as broad as the simplex; accessory gland white, transparent 9.4 mm long, uniformly broad throughout; ductus ejaculatorious simplex white, transparent, primary segment 8.5 mm long, uniformly broad, cuticular muscular area 1.4 mm long, comparatively broader, transparent and curved.

Ovaries yellow coloured, comparatively short, broad, each ovariole measuring 7.9 mm long, constricted clearly with 45-50 ova; terminal filament white, short and tapers gradually; lateral oviduct 0.2 mm long; common oviduct 0.6 mm long containing two ova; spermathecal gland white, 2.2 mm long, its tip blunt and bifurcated; spermatheca unilobed, utiriculus sclerotized, 0.2 mm long, slightly constricted, spermathecal duct 0.45 mm long as broad as the gland; accessory glands 7.4 mm long, white in colour, its width uneven, with tip blunt; lateral reservoir 1.7 mm long, membranous, elongated; common accessory duct 0.3 mm long, membranous; corpus bursae 0.9 mm long, transparent, membranous; ductus bursae 1.3 mm long, dorsoventrally flattened, transparent, curved; ostium bursae surrounded by a well developed genital plate, the later heavily sclerotized; ductus seminalis 0.25 mm long, narrow, curved, originating from the lateral side of the ductus bursae; anterior and posterior apophyses moderately sclerotized. Ovipositor lobes normally setosed with macro and micro setae.

Material examined:

Holotype ♂, INDIA: Patiala (Punjab) 3.vii.1984, light: Paratypes 3 ♂♂, 2 ♀♀ collection data as for the holotype, August to October, 1984. Material has been deposited in the Department of Zoology, Punjabi University, Patiala-147 002. Punjab: India.

Remarks:

The ground colour of the species under reference is dull green and generally resembles other congeneric species of the genus *Chlorissa* Stephens. The new species is, however, more allied to *C. albifasciata* Pajni and Walia but differs in the socii being symmetrical in the new species and assymmetrical in *C. albifasciata.* Moreover in the structure of the aedeagus the number and arrangement of cornuti on vesica is quite different in both species.

Acknowledgements

We thank Prof. H. R. Pajni and Dr. V. K. Walia of the Department of Zoology, Punjab University, Chandigarh-160 014 for their valuable comments on the identity of the species.

Reference

Pajni, H. R. & Walia, V. K. (1984): Taxonomic studies on Indian Geometridae 1. Genus *Chlorissa* Stephens (subfamily: Geometrinae). *Entomon* 9(1): 39-46.

PRIMULA SUBANSIRICA — A NEW SPECIES FROM ARUNACHAL PRADESH, INDIA[1]

G. D. PAL[2]

(*With eight text-figures*)

Primula subansirica sp. nov.

Primula erythra Fletcher affinis, sed differt pilis 4-10-cellularibus omnino tectis, scapis 13-20 cm longis, umbellis 4-6-floris, bracteis late lanceolatis ad oblongo-lanceolatis, 4-5 x 2.5-3.0 mm, calycibus 3.5-4.0 mm longis, breviter connatis, corollis 7.5-8.0 mm longis, campanulatis, purpureis.

Holotypus lectus ad locum Begi, Subansiri District, Arunachal Pradesh, India, alt 2000 m, die 24.4.1980, a *G. D. Pal* sub numero 78219 et positus in CAL; Isotypi *G. D. Pal* 78219 A-B positi in Arunachâl Pradesh.

Primula subansirica sp. nov. is allied to *Primula erythra* Fletcher but can be differentiated by the presence of 4-10 celled pubescent hairs throughout, scape 13-20 cm long, bracts broadly lanceolate to oblong lanceolate, 4-5 × 2.5-3.0 mm, 2-6 flowered umbel, calyx 3.5-4.0 mm long, shortly united, corolla 7.5-8.0 mm, campanulate, purple.

Primula subansirica sp. nov.
(Figs. 1-8)

Perennial scapigerous herbs, 20-30 cm high, efarinose, rusty red; rootstalks oblong to oblong-cylindric with fibrous root, thickly pubescent; hairs rusty red, 4-10 celled. *Leaves* cauline, lamina ovate-cordate, 4.0-6.5 × 3.0-5.5 cm, obtuse, crenate, base cordate, 5-6 secondary nerved, subpubescent above, densely pubescent beneath much along the nerves as well as margin, herbaceous; petioles 7-12 cm long, densely pubescent. Scapes 3-6, longer than leaves, occasionally equal, 13-20 cm long cylindric, pubescent, with umbel of 2-6 flowers. *Flowers* monomorphic, erect to semierect, campanulate, purple. *Bracts* 2-5, broadly lanceolate to oblong-lanceolate, 4-5×2.5-3.0 mm, acute, with 1-2 mm rusty red hairs, with prominent nerves, pubescent on both surfaces. *Calyx* 5 lobed, united; lobes oblong, 3.5-4.0 × 0.8-1 mm, with prominent nerves, pubescent beneath, both margin and apex with 1-2 mm long hairs. *Corolla* campanulate, exannulate, united portion 5 mm glabrescent; limbs 5, obcordate, faintly emarginate, 2.5-3.0 × 5-6 mm, nerves reddish, not much prominent. *Stamens* 5, inserted at the apex of corolla tube; filament *c* 2 mm long; anthers ovoid, *c* 2×2 mm; yellow. *Ovary* ellipsoid, *c* 2×1 mm; style *c* 2 mm long, equal to the length of limb or slightly longer; stigma capitate. *Fruit* unknown.

Type: INDIA: Arunachal Pradesh, Subansiri district, Begi, alt. 2000 m, 24.4.1980, *G. D. Pal* (CAL-Holotype): *G. D. Pal* 78219 A-B (Arunachal Pradesh-Isotype).

Forest edges, along the edge of steep hill slopes, on rocky and humus soil in shaded places.

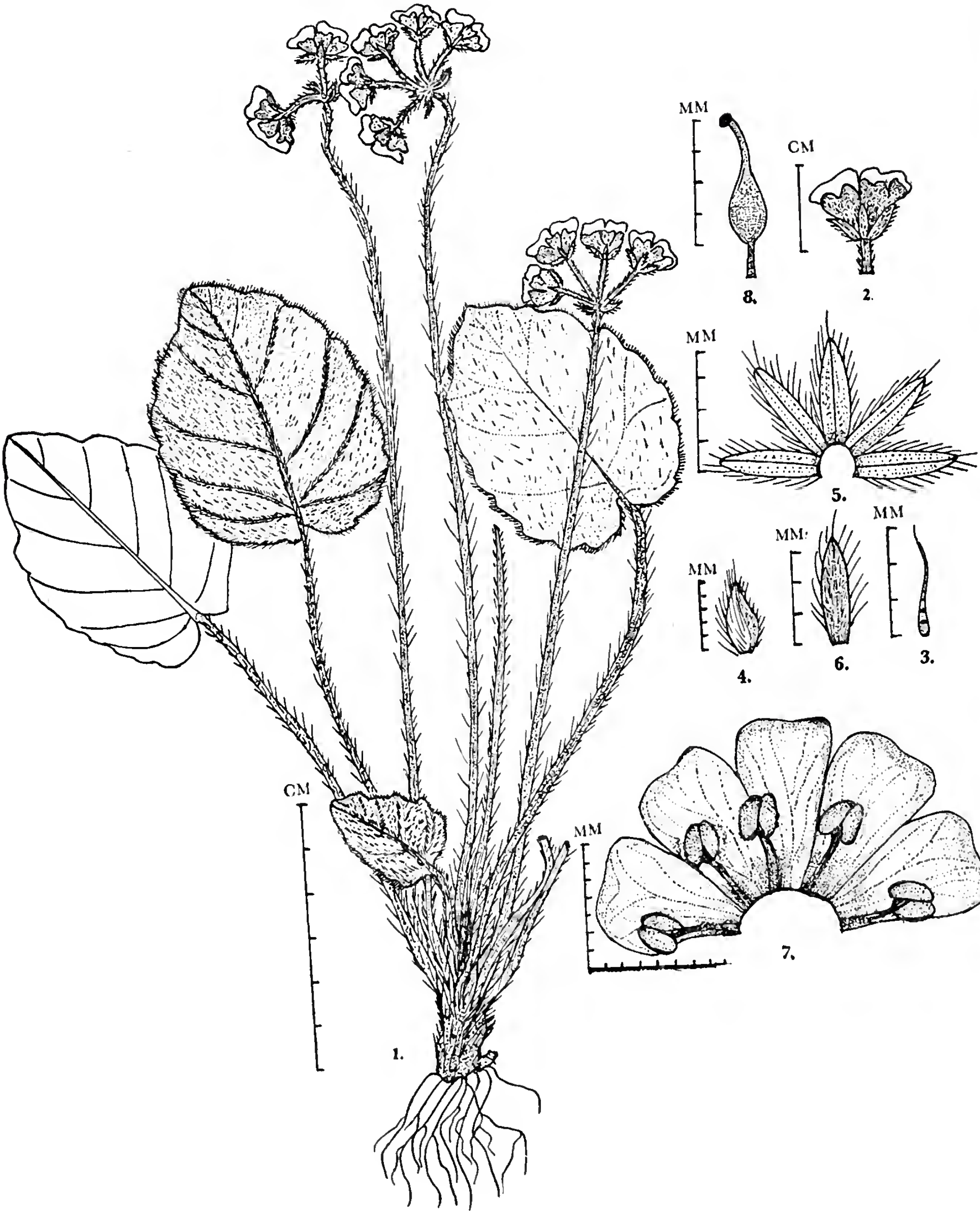
The specific epithet is based on the name of district of type locality Begi.

ACKNOWLEDGEMENTS

I thank Dr. M. P. Nayar, Director, Botanical Survey of India for providing facilities and encouragement; Dr. K. Thothathri, Joint Director, Botanical Survey of India, for going through the manuscript and Dr. N. C. Majumder, Ecologist, Central Botanical Laboratory, Howrah, for rendering the latin description.

[1] Accepted July 1985.

[2] Botanical Survey of India, Arunachal Field Station, New Itanagar-791 111.



Figs. 1-8. *Primula subansirica* sp. nov.
1. Plant; 2. Flower; 3. Celled-hair; 4. Floral bract; 5. Calyx (ventral view); 6. Part of calyx (dorsal view); 7. Corolla with androecium; 8. Pistil.

A NEW SPECIES OF *HEDYOTIS* L. (RUBIACEAE) FROM SOUTH INDIA[1]

D. B. DEB AND RATNA DUTTA[2]

(*With a text-figure*)

In course of the study of the taxonomy of the genus *Hedyotis* L. (Rubiaceae) some specimens collected from Kerala and Tamil Nadu were noted as misidentified as *H. stylosa* R. Br. ex Wt. & Arn. (= *H. leschenaultiana* DC.) or *H. eualata* (Bedd. ex Gamble) Henry & Subram. On critical study these collections represent a new species described below:

Hedyotis devicolamensis sp. nov.

Planta inter *H. leschenaultiana* DC. et *H. eualata* (Bedd. ex Gamble) Henry et Subram., differt a *H. leschenaultiana* DC. paniculis umbellatis, pedicellis brevioribus, calycibus lobis longissimis, corollarum tubis latioribusque a *H. eualata* (Bedd. ex Gamble) Henry et Subram. ramulis floriferis brevioribus, pedicellis brevioribus, calycum tubis multo prolongatis supra hypanthium, corollarum tubis latioribus atque capsulis subglobosis ad oblongis.

Hedyotis devicolamensis sp. nov.

This is almost intermediate between *H. leschenaultiana* DC. and *H. eualata* (Bedd. ex Gamble) Henry et Subram., differing from *H. leschenaultiana* DC. in umbellate panicles, shorter pedicels, calyx lobes very long and corolla tube broader, and from *H. eualata* (Bedd. ex Gamble) Henry et Subram. in shorter flowering branches, shorter pedicels, calyx tube much produced above the hypanthium, corolla tube broader and capsule subglobose to oblong, amongst others.

Shrubs or undershrubs, 1-2 m in height, branching above; stem quadrangular, or often with prominent ridges, grooved, glabrous. *Leaves* petiolate, 2.2-11 cm x 0.9-3.5 cm, ovate-lanceolate or elliptic-lanceolate, acuminate at apex, attenuate at base, coriaceous, yellowish or pale green when dry, glabrous, rarely pubescent along the margin when young; nerves subopposite, 5-7, on either side, oblique, usually strong; petiole 3-10 mm long; stipules 2.4-4 mm x 7-8 mm, adnate to the petiole at base, pectinate, with 5-9 bristles, pubescent, glandular, black at apex. Inflorescence in terminal and axillary panicles short, stout, umbellate cyme. *Flowers* pedicelled, 7-10 mm long, heterostylous, bracteate and bracteolate; pedicel 0.5-1 mm long; bracts foliaceous, lanceolate; bracteoles small, fimbriate. *Calyx* 4-lobed, glabrous; hypanthium ovoid, 1-1.2 mm long; tube 0.8-1 mm long; lobes 2-3 mm x 1-1.5 mm, linear-lanceolate, acute, sparsely pubescent along the margin; dense raphides present all over. *Corolla* broadly tubular, white, or pale violet; tube 3.5-5 mm long, 1.5-2.5 mm broad, often as long as the calyx lobes. Corolla lobes 2-3 mm x 1-1.5 mm, oblong, acute, incurved and beaked at apex, puberulous outside, minute pubescent inside, dense pubescent at throat. *Stamens* 4, inserted at the sinus of corolla lobes, included or exserted; filaments 1-1.5 mm long in short styled flower, and 0.2-0.5 mm in long styled flower; anther 1-1.9 mm long, linear. *Ovary* 2 chambered, many ovuled on median placenta; style 3-3.5 mm

[1] Accepted April 1985.

[2] Botanical Survey of India, Howrah.

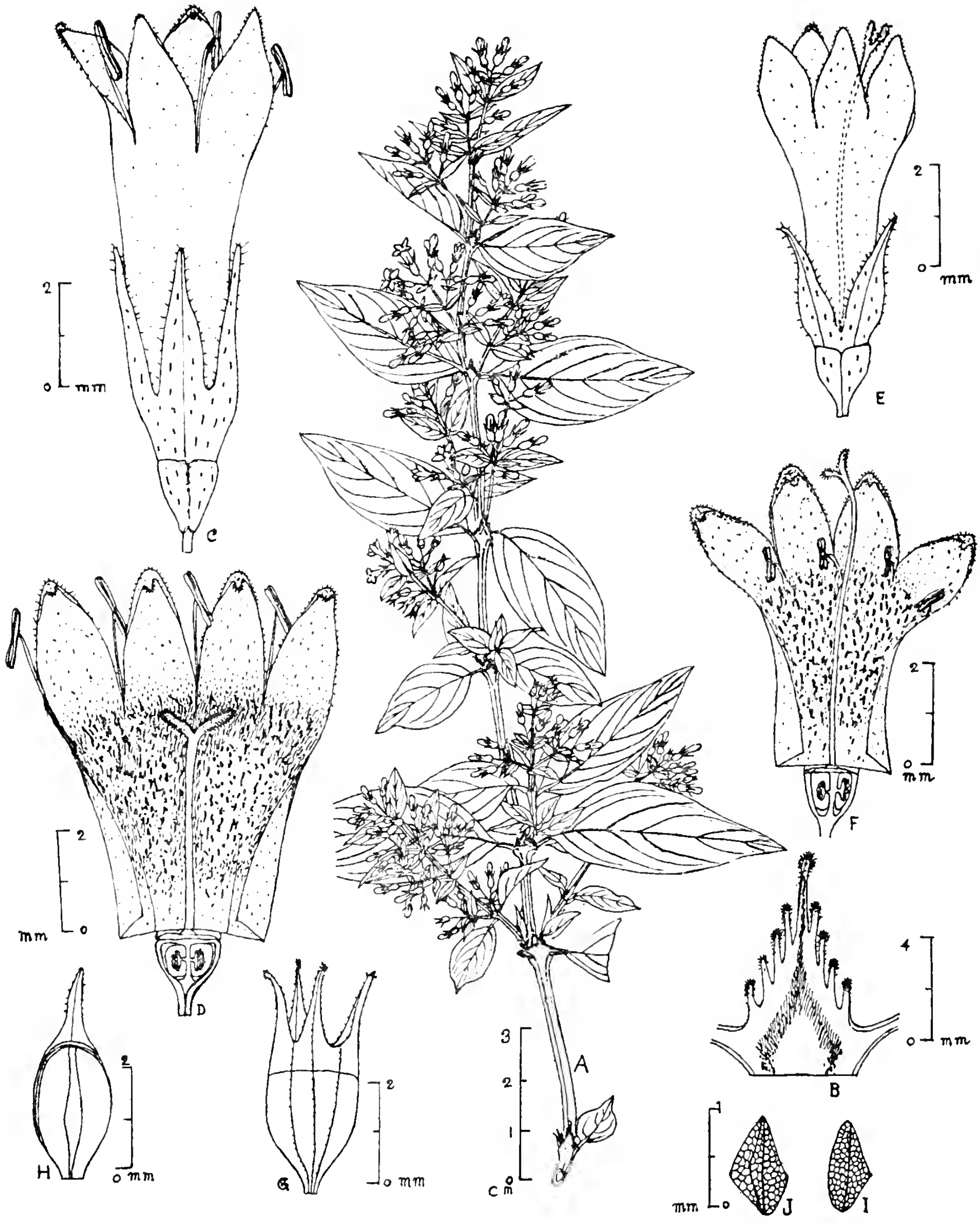


Fig. 1. *Hedyotis devicolamensis* sp. nov.

A. Habit; B. Stipule; C. Short styled flower; D. Corolla split open showing stamens, style and stigma; E. Long styled flower; F. Corolla split open showing stamens, stigma, style and ovary; G. Capsule; H. Septicidally dehiscing, mericarp; I.&J. Seeds.

or 4-8 mm long, glabrous; stigma bifid, 0.8-1 mm long, fleshy, papillose. *Capsule* subglobose to oblong, 5-6 mm x 2.5 mm, crustaceous, glabrous, dehiscing septicidally. *Seeds* 10-12, angular or plano-convex, narrowly winged, 0.8-1 mm x 0.5-0.6 mm; testa reticulate, brownish in colour.

Type: Kerala state, Kottayam district, Devicolam, 11.9.1968, *D. B. Deb* 30480 (holo. CAL) & *D. B. Deb* 30481 (iso. CAL); Umaiya Malei, 2025 m, Devicolam, 17.4.1966, *B. V. Shetty* 27311 (para, CAL); Rajamallai, 1950 m, 2.2.1970, *B. V. Shetty* 31783 (para, CAL); Devicolam, 25.1.1964, *K. M. Sebastine* 18458 (para, CAL).

Other specimens: *Tamil Nadu*: Brahmagiri sholas, 1380 m, *C.E.C. Fischer* 258 (CAL); Coimbatore District, Akkamalai, 1575 m, *J. Joseph* 13768 (MH); Akkamalai R. F. 1500 m, *J. Joseph* 15534 (MH); Konalar, *R. Makali* 65900 (CAL).

Distribution: Kerala and Tamil Nadu; common at 1500 m-2025 m in altitude.

ACKNOWLEDGEMENT

Thanks are due to the Director, Botanical Survey of India and Deputy Director, Central National Herbarium, for facilities to conduct this study.

REVIEWS

1. THE FALL OF A SPARROW. By Sálim Ali. pp. viii+265 (22×14.5 cm), with 72 photographs on monochrome plates and 3 fascimiles. Delhi, Bombay, Calcutta, Madras, 1985. Oxford University Press. Price Rs. 110/-.

Very few people have been blessed enough to grow up with such an exciting century as the 20th Century has been and continues to be. Sálim Ali has had the good fortune. Eight decades of a revolutionary century and about seven of them spent in the unflagging pursuit of a subject dear to his heart, the study of birds. In this autobiography he traces the origin and describes the growth of his enduring passion for birds. The wild and exotic places and the people he met in his quest, the trials and disasters, and the final triumph. It is the triumph of a strong will considering the odds. He was born in a family of achievers, in an age when education leading to degree was the road to success for the middle class, and no deviation was permitted from the beaten path. Anyone out of step was looked at with dismay, and subjected to enormous psychological and other pressures to bend the errant person to the common will.

Sálim Ali successfully withstood these subtle and not so subtle pressures ably abetted first by his wife and later by his sister. To them he has abundantly acknowledged his gratitude.

His wife especially saved him from the dreariness of attending to mundane chores while on camp and assured that shoe-string budgets on which he operated the various field camps did not break under the strain.

Single minded devotion to an objective could make a person tiresome to others, but Sálim Ali's abiding grace is a wonderful sense of humour and a singularly uninflated ego, which enables him to look at himself and others without pretensions.

What he has achieved is remarkable considering the slender resources he had operated on over the years. As far the scientific output by Sálim Ali is concerned one would agree with the Bombay Municipal Milk Inspector whom Sálim Ali quotes that "The pay is small but the income is good".

A remarkable book by a remarkable person.

J. C. DANIEL

2. (1) VRUKSHGAN. By Sharadini Dahanukar. pp. 96 (21.5×14 cm), with twelve colours plates & many illustrations. Pune, 1984. Shrividya Prakashan. Price Rs. 45/-.

(2) KAPASHICHI DIARY. By Kiran Purandare. pp. 96 (21.5×13.5 cm), with many illustrations. Pune, 1984. Nisarg Prakashan. Price Rs. 35/-.

In the last few years, there has been an increase in the interest in natural history and conservation largely due to the efforts of organisations such as BNHS., W.W.F.—India and from a number of books published on the subject. A large number of newspapers and magazines have also included 'nature' as a regular subject which has helped in popula-

rising these subjects. However, a big void remains, as there are very few books in regional languages.

The publication of these two books in Marathi is welcome and the authors deserve credit for their efforts.

VRUKSHGAN is veritably a poem on trees. The book originated from a series of articles written by the author in a Marathi daily, Maharashtra Times. While describing various trees in fluent, poetic but simple language, the author also gives considerable scientific and other interesting information. The author has simplified scientific names giving their origin and has also described Sanskrit & Marathi names. She also mentions various uses and medicinal properties of the trees. The book has 12 colour plates and many illustrations showing various parts of trees. This useful, informative, book is made more attractive by the beautiful printing & layout and the artistic cover design by Shri Subhash Awachat.

KAPASHICHI DIARY is an account of bird observations by an amateur. The book basically describes observations on a pair of Blackwinged Kites and their nest, but it also gives an account of bird observations in the surrounding regions. In the course of the introduction, the author narrates his experiences to show how his bird watching hobby has now turned into more scientific ornithological study. In simple, attractive language, the author narrates how an individual can take interest in the hobby and experience wonderful moments in the company of nature.

The chapter on birds in mango trees illustrates how one can do interesting bird observations in a small patch of trees near the city. Detailed observations on the nest of the Blackwinged Kite gives us some interesting information. The notes on the nesting behaviour of birds, protection of the nest, feeding and protection of the chicks, first flight of the young ones and predation of one of the chicks (probably by spotted owlets), give us first hand important scientific information.

One important point that comes to mind while reading the book is the necessity for standardisation of local names of birds. The names already in use by local people should preferably be used. New names should be given in simple language, wherever necessary, but here standardisation is essential.

Marathi literature already has some welknown books on nature by Smt. Durga Bhagwat, Shri Maruti Chittampalli, Shri Vyankatesh Madgulkar, Shri Prakash Gole etc. The entry of these two new authors in the field is definitely welcome.

ULHAS RANE

3. WILDLIFE RESOURCES AND ECONOMIC DEVELOPMENT. By S. K. Eltringham. pp. xii+325 (23×15 cm), with 16 photographs and many illustrations. Chichester, 1984. John Wiley & Sons. Price not quoted.

With increasing demands upon wildlife resources and wildlife habitats during the current century, it is surprising that conservationists took so long to embark upon a detailed evaluation of wildlife as a worldwide economic resource, to counteract the other economic demands upon wildlife habitats and the short-sighted, destructive, exploitative practices which have drastically impoverished wildlife as an economic resource. It was only in the late 1960s that monographs and careful analyses in this regard really began to appear, though the pioneering works of Ray Dasmann and others, and the success story of the Saiga

antelope had already proved a decade earlier that if wisely harnessed, wildlife resources could play a vital part in economic development.

In this context, therefore, the book under review is indeed a very welcome addition to conservation literature, and is perhaps the most comprehensive work on the subject today. It deals with wildlife utilization for food and non-edible purposes; wildlife cropping as different from culling; wildlife ranching; wildlife population ecology; game hunting; wildlife tourism and possibilities of new domestication of wild species. The scope of the work is limited to undomesticated animals; wild plants are not included. And though a part chapter is devoted to fishing, this very crucial wildlife resource is dealt with but briefly in the book. The consideration of the size of the book in relation to the vastness of the topic of wildlife as an economic resource in the full ambit of the term, must in all probability account for these curtailments.

Previous works on the subject of wildlfie as an economic resource, amongst them the treatises of J. Sale, A. de Vas, Asibey, Child, Clark & Mitchell, were mainly concerned with Africa & North America, with some attention to Europe and Australia. South America, Oceania and Asia were but cursorily dealt with, and this regrettably is also the case with the book under review. This omission is perhaps accounted for by the fact that enough data is not readily available for these regions, but then this is precisely what must be investigated, because it is in these parts of the world that wildlife is under the greatest threat.

The author deals at some length with the various methods of estimating the maximum sustainable yields (MSY) of wildlife populations, and comes to the sensible conclusion that "It is as yet impossible to calculate accurately the MSY of any wild population from theoretical formulations. Harvesting must therefore continue to be conducted on an empirical basis and the MSY guessed, but it is nevertheless desirable to estimate its value by one or other of the various techniques described." In the hands of the uninitiated, however, the various theories propounded to ascertain MSY could lead to grave errors in practice, as they have in the past, and it is far safer to work out the optimum sustainable yield (OSY). Even here there are many imponderables, which the book unfortunately does not deal with. Should one allow the populations to build upto the optimum carrying capacity of the habitat before undertaking OSY cropping? If so, how does one calculate OSY of that carrying capacity?

The exposes on ivory and rhino horn trade are detailed and well documented, based mainly upon the works of the IUCN TRAFFIC group and E Bradley Martin. One would have wished to have had a more detailed discussion on the potential of krill as a world protein resource.

On page 111 the name Kajiado district of Kenya is mis-spelt twice as Kjiado, though elsewhere the word is correctly spelt. In dealing with crocodile farming, there is no mention of the world's pioneering and to date the most successful crocodile farm of Youngprapakorn in Thailand. In the sub chapter dealing with indigenous cultures dependent on wildlife, there is no mention of the peoples of Papua New Guinea, whose dependence on wildlife is second to none in the world.

These, however, are but minor aberrations in what is a work of major significance and relevance in the humdrum, development-oriented world of today. One only hopes that it would form a catalyst to further studies on the subject in developing countries.

M. K. RANJITSINH

4. THE BIRDS OF THE WETLANDS. By James Hancock. Foreword by Ian Prestt. pp. 152 (25×19.5 cm), with many coloured photographs. Bombay, 1984. Oxford University Press. Price Rs. 135/-.

The diminution of wildlife particularly of the larger mammals and birds was noticed everywhere after the termination of the Second World War and attempts were made to protect them in many countries. The first effort in most places was to ban all shooting. But it was soon realised, (though not always admitted) that the preservation of the environment is equally (if not more) important and the first and perhaps the most easily protected form of habitat was found to be marshes and other areas more or less permanently under water, which together with their surroundings provided refuge to a large number and variety of birds. This led almost simultaneously to the addition of a new term "wetlands" to the English language.

There were such areas all over the world which remained unmolested because they were more difficult to reclaim to build upon or for cultivation or owed their existence to sportsmen who wished to preserve the sport which they had enjoyed thereon. It was soon realised however that wetlands were also threatened as more water was required for other purposes and left to themselves, the marshes would soon be drained, silted or reclaimed and this stronghold was also going.

The present volume deals with one or more outstanding wetland in each continent and in addition to being an excellent introduction to wetlands in different parts of the world, the Florida Everglades in North America, various parts of South America, the Tana River, Kenya in Africa, Bharatpur in India, and so on, we are treated to the large number of excellent photographs mostly of water birds.

The author has also produced THE EGRETS OF THE WORLD and there are interesting observations on the color changes in the bill and tarsus of the different species, again drawing attention, if it were necessary, to the need of such notings in India.

The chapter on Bharatpur is of particular interest to us and as in the others, is illustrated with excellent photographs. It is stressed that the place owes its origin to the shooting parties of the Maharaja. It is true that at times inordinate numbers were shot and while the population could possibly once stand this attack, the limits of sport were exceeded and there was a reversion in other directions. Now it has been made a national park and it is hoped that it will be possible to get over the several problems which have risen, e.g. determining if the growth of the grass and clogging of waterways is due to the stoppage of cattle grazing which was one of the first efforts at conservation within the sanctuary.

The author has visited the place several times and has a Checklist of birds but it is not clear if all were seen by himself or by others. However the list contains several species for which the earlier records have not been satisfactorily established, e.g. *Accipiter gentilis, Chlidonias niger, Pericrocotus flammeus, Cisticola exilis, Acrocephalus concinens, Phylloscopus affinis, fuscatus* and *proregulus, Anthus spinoletta.* And do 2 species of iora really occur at Bharatpur ?

It is strange that he makes no reference to the BNHS Hydrobiology project which has been working there for several years and which he no doubt saw in action.

Bird photography is catching on in India

but it is hoped that the natural study of bird life and the factors necessary for their survival will also receive attention and permit their preservation. The example set in the wetlands must also be extended to dry land and forests before it is too late.

HUMAYUN ABDULALI

5. THE BOOK OF INDIAN REPTILES. By J. C. Daniel. pp. x + 141 25 × 17 cm), with many coloured and black-and-white plates and illustrations. Bombay, 1983. Bombay Natural History Society. Price Rs. 75.00*

The last summary of the systematics and biology of the Indian reptiles was by Malcolm A. Smith. His three volume series (1931, 1935, 1943) covered a much wider area: British India and the entire Indochina peninsula. Just as this area has experienced much political and cultural change, knowledge of the Indian reptiles has also changed and grown with the contributions of many Indian and foreign biologists. Daniel's book is a useful summary of this new information on the natural history of Indian reptiles: i.e., those living on the Indian peninsula, particularly in the Republic of India. Daniel notes in the preface that the new data derive largely from articles published in the *Journal of the Bombay Natural History Society*, but it is clear that the author kept abreast of the literature published elsewhere. Systematics is not emphasized; only the current scientific name is given for each species and, where a consensus of usage has not been reached, Daniel follows the older usage.

The book emphasizes the common Indian species but includes information on many of the more elusive and rarer species as well. The text is organized into five major sections: introduction, crocodiles, turtles and tortoises, lizards, and snakes. The introduction provides a thorough and concise introduction to reptiles. In each of the taxonomic sections, the common species are detailed with subsections giving local (colloquial) names; maximum size; features for identification; coloration; habitat, distribution and status information; general data on habits, often noting the lack of detailed information; diet and feeding habits; reproductive data; and miscellaneous items of special interest. The rarer species are included in accounts of the common species to which they are most closely related: e.g., the account of the Indian Flap-shell Turtle contains all of the other trionychid species, and the account of the Northern House Gecko contains nine other gecko species. Each rarer species is described in a short paragraph giving identification characteristics and natural history notes. Overall, three crocodilians, 28 turtles and tortoises, 45 lizards, and 49 snakes are presented, about half by full accounts. The species are illustrated in a variety of ways: line drawings, black and white photographs, color photographs, and reprints of classic color plates. The mixture is esthetically pleasing as well as providing accurate and helpful illustrations for recognizing the different species. I particularly liked the colored photographs of geckos and the colored plates of snakes from Wall's series in early numbers of the *Journal*. The text is followed by a literature cited section, additional readings, a glossary, and a combined index of common and scientific names.

Reprinted from *Herpetologica* 41(2): 236-237 (June 1985).

* Presently @ Rs. 85/-.

The book is well written and, although not stated, written for a student and lay audience. This goal has resulted in a highly readable text and does not detract from the book's usefulness for herpetologists and other zoologists. The author deserves high praise for the quality of this book from its highly readable summary of the Indian herpetofauna, selection of excellent illustrations, and meticulous editing and proof-reading. I strongly recommend this book for everyone interested in Asian zoology. It is a quality book and a real bargain in these days of inflated book prices.

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6. THE BREEDING BIRDS OF EUROPE: A Photographic Handbook. By Manfred Pforr and Alfred Limbrunner. Translated by Richard Stoneman. Edited by Iain Robertson. Vol. 1, Divers to Auks. pp. 327 (21×20 cm) with many coloured plates. London, 1981*. Croom Helm. Price £14.95. Vol. 2, Sandgrouse to Crows. pp. 394 (21×20 cm). with many coloured plates. London, 1982*. Croom Helm. Price £17.95.

The number of books appearing about birds is increasing and it is hardly possible to keep in touch with everything published. Also with the most sophisticated photographic and printing equipment available, the quality of the pictures is steadily improving but I would not hesitate to say that the pictorial value of the present pictures of the breeding birds of Europe, often representing both sexes when they show a difference, their seasonal changes, their nests and eggs, accompanied by distributional maps and a little text are far superior to anything which has been published — certainly on the Indian market.

There are many odd facts which draw attention — e.g. most of the 127 species of cuckoos in the world are said to rear their own young. Pigeons drink by sucking, a habit only shared with sandgrouse and button quail. In some owls, the ears are asymmetrical which allows very accurate pin-pointing of sounds. The outer web of the primaries has a comb-like structure of filament preventing the air from whistling against a hard edge. The tongue of the woodpeckers is long with a barbed tip and covered with a glue-like secretion which enables them to extract larvae from holes deep in the wood.

The incubation period of the white pelican is 30 days. Some bitterns are polygamous. The great flamingo chicks are fed on a glandular secretion known as crop milk.

Many such interesting factors are brought out and the short references together with the photographs make fascinating reading.

The damage caused by the extent of photographing at the nest, which is becoming more and more evident in India is stressed by the statement in the introduction that "photographs of endangered species included in this book were obtained at a time when the danger was not recognised or by taking the greatest care to avoid disturbance which might affect the success of the nest".

There is also a list of 35 species in Volume 1 of which it was not possible to obtain photographs because of their rarity. Curiously they include the blackwinged kite and the purple coot, both so common in India.

The photographs are picked from those taken by 42 persons mostly from West Germany and is another instance of what fine results can be obtained by collaboration.

The price is high but the pictures and text are worth the money. We wonder when an equivalent work will be available in India.

Humayun Abdulali

* Received for review in September 1985.

MISCELLANEOUS NOTES

1. ON SOME ASPECTS OF REPRODUCTION AMONG THE TIGERS (*PANTHERA TIGRIS*) OF NANDANKANAN BIOLOGICAL PARK (ORISSA)

The purpose of the present communication is to present data on some aspects of reproduction observed among the captive tigers at the Nandankanan Biological Park, Orissa during the period from January, 1964 to October 1979. The observations of earlier workers have been cited.

Materials and Methods

The Nandankanan Biological Park, Orissa was opened to the public on 29th December, 1960. The first full grown tigress of the Park was received from Alipore Zoological Gardens, Calcutta in January, 1964 and she was paired with a full grown tiger of the same Park in November, 1965. The first birth of tiger cubs in the Park was recorded in December, 1966. So far 28 tiger cubs have been born in the Park to four tigresses in twelve litters.

The tigers in the Park are kept in spacious enclosures, each of which has two adjacent retiring cells. Usually the tigers are kept in pairs and separated about a fortnight before the expected date of parturition till the cubs are about 9 months old.

The tigers are fed six days in a week with beef and on Mondays of each week no food is given. On an average each adult tiger is given 14 Kg of fresh raw beef with bones daily. Vitamin supplements such as Vitablend AD3 (Glaxo) or Becadex Multivitamin tablets (Glaxo) are added to the beef intermittently.

The weight and size of tiger cubs at birth was recorded within about twelve hours after their birth.

Observations and discussion

Sexual Maturity: One tigress born in the Park on 9.3.1975 was allowed to remain with a sexually matured tiger from the age of about 2 years and ten months (from 5.4.1978). Mating of this pair was first observed from 1.10.1978 to 5.10.1978 and subsequently from 15.11.1978 to 23.11.1978, from 27.12.1978 to 5.1.1979, from 13.2.1979 to 18.2.1979 and from 6.4.1979 to 12.4.1979 resulting in the birth of the first litter on 22.7.1979. These observations suggest that the tigress came to her first oestrus at the age of 3 years 6 months and 22 days or say about 3 years and 7 months but gave birth for the first time at the age of 4 years, 4 months and 14 days.

Chaturvedi (1970) states that the first cubbing of a tigress takes place at about the age of four and a tiger is fully grown in about 5 years.

The age of sexual maturity of two tigresses is given as about 3 years and of two tigers is given as about 4 years and about 3 years and 7 months respectively (Acharjyo and Misra 1975, Acharjyo and Mishra 1980). According to Crandall (1965) a female tiger became sexually mature soon after passing the age of $3\frac{1}{2}$ years whereas a male tiger became sexually mature at least 15 days before he reached the age of 4 years. The tiger cubs

mature at an age between $3\frac{1}{2}$ and 6 years (Sankhala 1967). Prater (1971) states that the lions and tigers take from three to five years to become fully adult but males and females are capable of breeding soon after, or even before they are three years old. Little has been published regarding the age at which tigers reach sexual maturity (Schaller 1972). The age of sexual maturity of this species is given as three years (Blanford 1888-91) and as four years (Abramov 1962, Novikov 1962). At the Whipsnade Zoo one tigress is said to have produced a litter at 2 years of age (Pocock 1939).

Mating Season: The mating of the tigers of the Park has been observed in all the months of the year. From April, 1967 to October, 1979; 36 matings were recorded as follows:

Rainy Season (July to October) — 11 (30.56%)

Winter Season (November to February) — 15 (41.67%)

Summer Season (March to June) — 10 (27.77%)

Many tigers in India seem to mate after the rains (Prater, loc. cit.). The tiger breeds all the year (Asdell 1964). According to Schaller (loc. cit.) the peak of sexual activity of tigers at Kanha was from November to about February with some mating probably occurring throughout the year. Sinha (1976) states that majority of mating in tigers of Palamau Tiger Reserve occurs during winter season (mid of October to mid of February) followed by summer (mid February to mid June) and possibly some mating occurs during rains also. Normally tigers mate in November-December or May and June (Singh 1973).

Oestrus period and inter-oestrus interval:

The details of our observations during the period from September, 1977 to October, 1979 is given in Table 1.

TABLE 1

Name of the tigress	Date of last mating observed (Oestrus period) without conception	Date of subsequent mating observed (oestrus period) with or without conception	Inter-oestrus interval in days
1	2	3	4
"Rekha"	28.11.78 to 5.12.78 (8 days)	28.1.79 to 1.2.79 (5 days)	53
"Ganga"	1.10.78 to 5.10.78 (5 days)	15.11.78 to 23.11.78 (9 days)	40
—do—	15.11.78 to 23.11.78 (9 days)	27.12.78 to 5.1.79 (10 days)	33
—do—	27.12.78 to 5.1.79 (10 days)	13.2.79 to 18.2.79 (6 days)	38
—do—	13.2.79 to 18.2.79 (6 days)	6.4.79 to 12.4.79 (7 days)	46
—do—	13.8.79 to 18.8.79 (6 days)	24.9.79 to 3.10.79 (10 days)	36

The Table 1 indicates that the period of mating (Oestrus period) in 9 cases among two tigresses varies from 5 to 10 days with an average of 7.33 days. The inter-oestrus interval observed in 6 cases among two tigresses varies from 33 to 53 days with an average of 41 days.

According to Acharjyo and Mohapatra (1979) the oestrus period observed in 19 cases among two tigresses varies from 2 to 8 days with an average of 5.2 days and inter-oestrus interval observed in 15 cases among two tigresses varies from 28 to 138 days with an average of 65.9 days. The oestrus in one tigress at the Basel Zoo was observed 21 times with an average interval of 51.9 days (range 20-84 days) and in another tigress it was recorded 18 times with an average interval of 54.2 days (range 27-83 days) (Schaller, loc. cit.). Sadleir (1966) states that the interval between the mid-points of 3 consecutive oestrus periods in one tigress varied from 45-55 days and the average length of receptivity during 14 oestrus periods was 7.1 days. The tigress is polyestrous, heat recurring at intervals of about 3 weeks (Crandall, loc cit.).

Gestation period: During the period from September, 1977 to October, 1979 the gestation period observed twice in two tigresses was 100 days and 101 days respectively calculated from the last day of mating to birth.

The gestation period observed on eight occasions among three tigresses of Nandankanan Biological Park from January, 1970 to August, 1977 varied from 98 to 104 days with an average of 101.13 days (Acharjyo and Mohapatra 1978). The gestation period is said to be 15 to 16 weeks (Prater, loc. cit.). Asdell (loc. cit.) states that the gestation period is about 113 days. The gestation period from the last observed mating is given as 100 to 108 days (Crandall, loc. cit.). The gestation period is about 100 days (Chaturvedi, loc. cit.).

Litter size and sex ratio at birth: The litter size of twelve births recorded to four tigresses of the Park during the period from December, 1966 to October, 1979 varied from 1 to 3 cubs with an average of 2.33 cubs per litter. The litter size of two births was one, of four births was two and of six births was three. There were 16 females and 10 males and the sex of the two cubs could not be known as they died and perished in the open-air enclosure. So the sex ratio (No. of males to 100 females) is 62.5 : 100.

The litter size of 79 litters born in Zoos varied from 1 to 5 with an average of 2.8 cubs per litter and the sex ratio of 196 cubs at birth born to these 79 litters was 100 males to 100 females (Schaller, loc cit.). The litter size varies from 1 to 7 (Brander 1923). The litter size is usually 2 to 3 but as many as 6 may be produced (Prater, loc. cit.). One tigress of the New York Zoological Park produced thirty two cubs in 11 litters from 1948 to 1959, the division of sexes being 19 males and 13 females and the litter size was 1 to 4 (Crandall, loc. cit.).

Distribution of births: The twelve births were recorded as follows: March, 1; April, 3; May, 2; June, 1; July, 2; November, 1; and December, 2.

The cubs are born at any time in the London Zoo but most are born from June to August (Asdell, loc cit.). The majority of young are born between February and May in India (Prater, loc. cit.). One tigress produced eleven litters at the New York Zoological Park as follows: May, 8; June, 1; and November, 2; (Crandall, loc. cit.).

Inter-parturition interval: The details of inter-parturition intervals recorded are given in Table 2.

TABLE 2

Specimen	Date of last parturition	Date of subsequent parturition	Inter-parturition interval	Period of separation of the female from the male from the date of last parturition mentioned in col. 2.
Tigress "Rani"	22-6-1973	9-3-1975	1 year 8 months and 14 days.	About 9 months. An abortion and observed after 40 days of conception on 8.11.74.
—do—	9-3-1975	22-5-1977	2 years 2 months and 12 days	About 9 months
Tigress "Rekha"	22-4-1977	12-5-1979	2 years and 19 days	About 17 months

The Table 2 indicates that inter-parturition interval observed on three occasions among two tigresses varies from 1 year 8 months and 14 days to 2 years, 2 months and 12 days with an average of 1 year 11 months and 25 days.

Acharjyo and Misra (1975) state that the inter-parturition interval observed in five cases among two tigresses varies from 4 months and 25 days to 3 years, 8 months and 9 days with an average of 1 year, 6 months and 5 days. Most cats have one or two litters a year, the larger species some times breed only every two or three years (Walker *et al.* 1964). In the wild the intervals between two successive cubbings is about three years (Chaturvedi, loc. cit.). In Zoos where the cubs are usually removed from the mother at birth, one litter per year is common and at London Zoo a tigress had 8 pregnancies between 1961 and 1964 including 3 births to this female in 1962 (Schaller, loc. cit.). He further states that a free living tigress that loses her cubs in some mishap is able to have a new litter within about 5 months.

Weight and size at birth: The weight and measurements of nine new born tiger cubs of the Park born during the period from 1.7.1972 to 31.10.1979 indicates that at birth the weight varies from 1.100 Kg to 1.430 Kg with an average of 1.247 Kg and measures from 50.5 cm to 54.0 cm with an average of 52.05 cm tip to tip including tail lengths of 15 to 17 cm (average 15.67 cm).

The weight of seven tiger cubs at birth varied from 0.920 Kg to 1.450 Kg with an average of 1.202 Kg and the length from tip to tip was 49 cm to 58 cm with an average of 53.4 cm. (Acharjyo and Misra 1972). Tiger cubs at birth weigh under three pounds (Denis 1964). At birth the three tiger cubs of New York Zoological Park measured 20 inches from the tip of the nose to the tip of the tail and their weights were 2 pounds 8 ounces (male), 2 pounds 9 ounces (male) and 2 pounds 11 ounces (female) (Crandall, loc. cit.).

Opening of eyes of cubs: The eyes of five tiger cubs, under observation (born during the period from 1.10.1973 to 31.10.1979) were closed at birth and opened on 7th day (two cubs), 9th day (two cubs) and 12th day (one cub).

According to Chaturvedi (loc. cit.) the tiger cubs open their eyes nine days after birth. The tiger cubs open their eyes in 15 to 16 days (Denis, loc. cit.). Crandall (loc. cit.) reported that the eyes of three tiger cubs were closed at birth and opened on 9th day (female), 11th day (male) and 17th day (male) respectively. The tiger cubs open their eyes in eight to fourteen days (Acharjyo and Misra 1973).

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2. A NOTE ON GOLDEN JACKALS (*CANIS AUREUS*) AND THEIR RELATIONSHIP WITH LANGURS (*PRESBYTIS ENTELLUS*) IN KANHA TIGER RESERVE

Field studies of golden jackals (*Canis aureus*) in East Africa and the Middle East have demonstrated considerable variability in social organisation (Wyman 1967, Macdonald 1979, 1983, Moehlman 1983). In the Serengeti plains, grasslands dominated by abundant, dispersed, ungulates, golden jackals live in small territorial groups (usually pairs), packhunt and disseminate their faeces singly (Wyman 1967, Lamprecht 1978). In contrast, in arid scrub bordering the Dead Sea in Israel, ungulates are unimportant and available food is predominantly scavenge, clumped at a few refuse and provisioning sites. Here jackals live in large territorial groups (10-20), scavenge and deposit their faeces in middens (Macdonald 1979). Macdonald (1979) also noted similar intraspecific variation for the striped hyena (*Hyaena vulgaris*) and suggested that group size and food dispersion are linked; clumped food, being an economically defensible resource, permits larger group size. The significance of midden as opposed to single faeces remains obscure.

Little is known of the biology of Asiatic jackals despite their abundance in a wide range of habitats. During a two year field study of Hanuman langurs (*Presbytis entellus*) in Kanha Tiger Reserve, Mandla District, Madhya Pradesh (1980-83) some incidental observations of golden jackal biology were collected. These records were obtained on the central Kanha maiden (80° 38′ E, 22° 17′ N), a mosaic of sal (*Shorea robusta*) forest, anthropogenic meadow and rocky outcrops ("chattans") vegetated with dry deciduous forest (Schaller 1967, Newton 1984). The Kanha meadows, although more wooded than the African plains, are similar to the Serengeti, particulary in terms of food dispersion, but quite dissimilar to the Dead Sea. Macdonald's (1979) hypothesis therefore predicts that Kanha jackals would packhunt in small groups and deposit faeces singly. Conversely, jackals scavenging at nearby Indian villages would be expected to live in large groups and form middens.

During 138 dawn to dusk follows of a langur troop, spread evenly throughout the year (April 1981-March 1982), golden jackals were observed on 72 occasions (0.52 sightings/day). Jackals were most frequently seen during the early monsoon (June-August, 1.08 sightings/day) and least frequently in the winter and late monsoon (September-January, 0.17 sightings/day). During this study an estimated 10-15 jackals inhabited the Kanha maiden, in contrast to the two pairs recorded by Schaller (1967) in 1963-64. Mean jackal group size was 1.5 ± s.d. 0.86 (range 1-6); 46 sightings were of lone animals and 20 of pairs. The small group size, indicating a solitary and paired existence, is similar to the jackals of the open plains of the Serengeti and quite dissimilar to the situation in Israel. Whether Kanha jackals were territorial was not determined.

Schaller (1967) concluded, from analysis of faeces collected from Kanha, that some 80% of jackal dietary volume was rodents, with reptiles and fruit also important, but scavenging or predation of ungulates relatively unimportant. During 1980-83 the latter component may have been more significant. In his 14 month study Schaller (1967) noted dhole (*Cuon alpinus*), an important predator of ungulates on the open meadow, only once,

whereas during this fieldwork dhole were seen some 70 times in two years. Dhole frequently made kills on the meadows, which were consistently scavenged by jackals. The latter usually waited to feed until the dogs had departed, but if they attempted to scavenge they were repelled by the dhole; on one occasion a dhole chased a jackal for some 150 m. Jackal faeces were distributed singly on the Kanha meadows, often on tracks or clumps of grass, similar to the pattern in the Serengeti and unlike the faecal middens found demarcating territories in Israel (Macdonald 1979).

Jackals occasionally coursed chital (*Axis axis*) in small packs (maximum 4) and in April 1981 two jackals were seen, in open meadow, to chase and kill a blackbuck fawn (*Antilope cervicapra*). The fawn was killed by being torn into two parts, through the abdomen. The adult female blackbuck present watched from nearby, but made no attempt to intervene. Schaller (1967), Prater (1980), Brander (1931) also noted jackal packs pursuing ungulates in India. Golden jackals have also been noted packhunting gazelle fawns in East Africa, killing with a similar technique to that observed in Kanha (Wyman 1967, Lamprecht 1978, Macdonald 1979, 1983). Unlike the Indian records, attendant gazelle does were observed to defend presumed offspring from attack.

Although jackals are unlikely to be important predators of adult langurs, being of similar size (Prater 1980), juveniles may be vulnerable, particularly in densely vegetated or dissected terrain. Schaller (1967) noted, from faecal analysis, the occasional consumption of langur, but was unable to distinguish predation from scavenging.

On 50 occasions jackals came within 50 m of the langur troop being watched, whose response was variable (Newton 1984). On six occasions agonistic interactions were observed:

1) On 22 April 1981 an infant-two langur of "M" troop approached 'C' troop, initiating an encounter in open meadow. As it crossed a nullah, a jackal ran from the bed, seized it and carried it off between its jaws. The 'M' adult male pursued the jackal for some 100 m, but did not catch up (Newton 1984).

2) A subadult female langur ran to within 1 m of a lone approaching jackal, bounced off a fallen log and retreated.

3) An adult female langur descended from a tree, ran towards an approaching jackal, and chased it away with an open mouth face threat (Dolhinow 1978).

4) A terrestrial adult female langur gave a hand slap threat onto the ground towards a approaching jackal 15 m distant. The jackal departed.

5) A jackal came within 10 m of a terrestrial adult female langur before being detected and chased away. On reapproaching, the jackal was chased away by the adult female and male langur.

6) A jackal chased an adult female langur to a tree, coming within 2 m.

Of 14.5% of jackal-langur proximities (<50 m, N=50) at least one langur climbed a tree in apparent response to jackal approach. In 5.8% of events all terrestrial langurs ascended trees. On 15.9% of occasions one or more terrestrial langurs moved towards the jackal(s). Of the 69 occasions in which langurs were heard to give vocalisations in apparent response to jackal presence, adult male 'hack' alarm calls were given on 52.2% (36), female 'chist' alarm calls on 37.7% (26) and female 'quavering' on 46.4% (32) (for terms see Newton 1984, Dolhinow 1978).

These limited data therefore suggest that jackals can be important predators of terrestrial langurs, particulary immature ones, dur-

ing lapses of vigilance. Close approach by jackals does elicit langur alarm calls and aggressive behaviour.

Jackals were occasionally seen to forage on, or 'glean', vegetation felled by langurs, dropped as a result of their feeding technique, by accident or as a result of arboreal displays (Newton in prep.). This scavenging most frequently occurred after the departure of the troop. However, on four occasions, when langurs were still present in the tree canopies above, jackals fed on dropped fruits: "jamun", *Syzygium cumini* fruits thrice and "lusari" *Cordia latifolia* fruits once. In the late hot weather and early monsoon the large quantities of langur and wind felled fruit probably made a substantial contribution to jackal diet. Jackals were also seen to feed on *Buchanania lanzan* and *Gardenia latifolia* fruits in leaf litter but never on the abundant flowers and leaves also felled by wind and monkey.

Langurs are unlikely to be directly important in plant dispersal because their specialised dentition and digestion destroys most seeds, with the probable exception of *Ficus* species. However, jackals may be important in seed dispersal. During the early monsoon many jackal faeces containing *Syzygium cumini* kernels (and one containing *C. latifolia*) were found on the Kanha maiden. The jamun faeces were very noticeable owing to the purple matrix derived from the fruit coat. This matrix was washed away during the rains leaving a characteristic deposit of germinating kernels. These fruits were necessarily obtained from langur and/or wind dropped vegetation. Therefore through jackal gleaning of langur waste, langurs may be indirectly important in fruit dispersal. Schaller (1967) recorded *Zizyphus* seeds in jackal faeces from the Kanha meadows and Coles (1893) noted the importance of jackals as seed dispersers, remarking that in south India they disseminate coffee beans (*Coffea* spp.). The right to collect this 'jackal coffee' was let out on lease to villagers.

These, albeit scanty, observations suggest that the Kanha jackal social system and habitat resembles more closely that found on the Serengeti plains than that in Israel (Wyman 1967, Macdonald 1979). In Kanha small groups packhunted and scattered their faeces singly. This correlation, across far-flung environments, between habitat and social organisation is compatable with Macdonald's (1979) economic defensibility hypothesis. Do jackals living around Indian villages behave as predicted?

I am greatly indebted to the Madhya Pradesh Forest Department for permission to carry out fieldwork in Kanha and for their cooperation. Mungal and Mohan Baiga provided excellent field assistance. I thank Gill Kerby and Dr David Macdonald for helpful comments on this note. The observations were made whilst in receipt of a SERC (UK) studentship.

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3. THE INDIAN BEAR *MELURSUS URSINUS URSINUS* FOR THE CONTROL OF TICKS (ACARI-IXODIDAE)

Ticks are pest and vectors of many important diseases of animals and man and many methods are in vogue for the control of ticks. Of these, acaricides are extensively used for the control of ticks all over the world. Biological control of ticks by Chalcid flies *Hunterallus* spp. has been tried to a certain extent but the results achieved so far are not convincing. Predators like Staphylinid beetle and ground squirrel *Citellus pygmaeus* are reported to feed on ticks (Sautet 1936, Flegotova 1938). Besides, crows are known to pick ticks from the body of animals in India.

During the course of collection of ticks from domestic animals in villages round about Dharwad (North Karnataka), it came to our notice that the villagers make use of an Indian Bear-*Melursus ursinus ursinus* for the control of ticks in cattle sheds. There are certain nomadic people who catch bear when young, tame them for "Bear-show", being paid in cash or in kind. They wander from village to village the 'Bear-shows' being their livelihood.

The village Marewad near Dharwad was heavily infested with *Boophilus microplus* ticks in December 1983. One heavily tick infested cattle shed was selected and a deal was made between the owner of the cattle shed and the bear owner for the control of ticks in exchange of 5 kg. of grains for the services rendered by the bear.

After the cattle and buffaloes were removed from the cattle shed, the bear was taken inside. The bear began to smell places where large number of larvae, nymphs and adult ticks were collected and began to swallow the ticks licking them up with its tongue. Other immature and adult ticks in crevices were sucked in and swallowed and those ticks deep inside the ground were

swallowed after excavating the ground with its claws. The entire operation took 15-20 minutes. This is a normal practice employed by villagers whenever a bear visits their village. A close examination of such treated cattle shed showed that the tick population on the body of cattle came down abruptly and ticks did not appear for the next 4-6 months.

This method has been found to be useful for the control of ticks in North Karnataka and does not involve risks associated with acaricides but it has got its own limitations since the bear population has come down heavily in recent years and bears will not be available whenever cattle owners require bears for the removal of ticks from the cattle sheds.

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4. FOOD AND NESTING HABITS OF *FUNAMBULUS TRISTRIATUS* WATERHOUSE IN MALABAR*

This paper deals with the annual diet and nesting habits of the Western Ghats squirrel, *Funambulus tristriatus* Waterhouse. Stomach content analysis revealed their omnivorous nature with termites and male flowers of coconut as the major food items. Nests were globular in shape and built at 2 to 29 m height on trees 4 to 30 m tall.

INTRODUCTION

The Western Ghats squirrel, *Funambulus tristriatus* Waterhouse is an arboreal rodent inhabiting the forest and cultivated fields in the west coast of south India (Moore and Tate 1965). Bhat and Mathew (1984 a and 1984 b) studied the population dynamics and reproductive biology of this species. Our knowledge on the food habits of this squirrel is limited to the bait preferences on captive animals (Bhat 1979). In this communication the observations made on the annual diet and nesting habits of the Western Ghats squirrel are discussed.

STUDY AREA

The study was conducted in 15 ha of mixed habitat near Vittal (12°30′N, 74°80′E), Karnataka, India from November 1977 to January 1979. The area was evenly divided among 3 habitat types: paddy (*Oryza sativa* L.) fields, arecanut (*Areca catechu* L.) plantations and woodland. The latter habitat had a few evergreen trees and shrubs. The common trees in this area were: *Aporosa lindleyana* Baill., *Careya arborea* Roxb., *Caryota urens* L., *Cin-*

* Part of the thesis submitted to the University of Calicut by the first author for the award of Ph.D. degree 1983.

namomum zeylanicum Bl., *Eugenia jambolana* Lam., *Holarrhena antidysenterica* Wall., *Phyllanthus emblica* L., *Sapium insigne* Benth., *Strychnos nuxvomica* L. and *Terminalia chebula* Retz. Coconut (*Cocos nucifera* L.), arecanut, cashew (*Anacardium occidentale* L.), mango (*Mangifera indica* L.), banana (*Musa paradisiaca* L.) and paddy were cultivated here. The shrub and herb community included *Caesalpinia mimosoides* Lam., *Calycopteris floribunda* Lam., *Ixora coccinea* L., *Lantana camara* L. and *Mimosa pudica* L. *Pandanus lerani* Jones, *Agave americana* L. and *Opuntia* sp. also were common but along the edges.

METHODS

Food habits.

Squirrels were collected by snap trapping using roasted coconut kernel as the bait. The animals were then dissected in the laboratory and stomachs removed. The contents of each stomach, after removing the bait, were emptied into a petridish and weighed to the nearest 0.05g using a toppan balance. A gross analysis of the total contents of each stomach was made with a dissecting microscope (40x) to identify the major food materials inside.

The volume of the major food materials was determined by water displacement following Sood and Dilber (1977) and Viljoen (1977). Items such as the exoskeleton of insects, which floated were immersed in water by pressing them with a fine sieve of known volume.

Nesting habits.

As the Western Ghats squirrels are diurnal in habit, their nests were spotted by following individual squirrel to its nest at dusk (after Broadbooks 1974). The inhabitant of each nest was trapped and its sex, weight and reproductive conditions were noted. The height at which the nest was located was measured and the nest was measured and the nest was removed for further observation. The nesting tree was identified and the site of location of each nest described.

RESULTS AND DISCUSSION

Food habits.

The Western Ghats squirrels examined by us were harmful as well as beneficial in their feeding activities. Among the plant food, male flowers of the coconut palm were most frequent in the stomach contents (Table 1). Only the central rudimentary pistil and the stalk of the stamens were consumed. Cacao, an important commercial crop in south India (Bavappa 1977), is also attacked. Bhat *et al.* (1981) reported the squirrel as one of the important rodent pests of cacao in south India. The grains of paddy, available only from December to February, were consumed mainly during that period. Of the 17 squirrels which took paddy, two (11.1%) had only paddy in their stomachs. In December and January, paddy grains formed more than 40% of the total food contents in their stomachs.

Crops pests such as termites, caterpillars, beetles and scales were also eaten consistently. Termites occurred more frequently (96.8% of stomachs) and in greater quantity (36.5% of volume) than any other food material in the stomachs of squirrels (Table 1). Of the 60 squirrels which took termites three (5.0%) had consumed termites only. The northern palm squirrel, *F. pennanti* also preyed upon large quantities of termites and caterpillars (Krishnaswami and Chowhan 1957). Insects (unspecified) were reported to be the most common food of the northern palm squirrel by Sood and Dilber (1977). The latter authors considered the northern palm squirrel to be

TABLE 1

SUMMARY OF FOODS EATEN BY *F. tristriatus*, DECEMBER 1977 TO JANUARY 1979 (THE FIGURES IN LEFT DENOTE PERCENTAGES BY OCCURRENCE AND THOSE WITHIN PARANTHESIS PERCENTAGES BY VOLUME) TR. TRACE

Food	Season		
	Winter (Nov.-Jan.)	Summer (Feb.-May)	Rainy (June-Aug.)
Paddy grains	56.0(22.8)	7.1(1.6)	—
Male flowers of Coconut	52.0(6.6)	39.3(11.9)	44.4(11.1)
Mucileage of cacao beans	12.0(3.0)	28.6(14.8)	22.2(8.5)
Cashew apple	—	28.6(13.9)	—
Fruits of Kokra Laurel	—	—	11.1(8.0)
Flowers of silk cotton	20.0(9.3)	—	—
Dried wood	28.0(tr)	46.4(8.5)	11.1(1.1)
Termites	100.0(30.3)	92.9(35.2)	88.9(18.2)
Black ants	20.0(1.4)	50.0(4.7)	33.3(tr)
Beetles	16.0(tr)	21.4(tr)	33.3(tr)
Caterpillars/grubs	44.0(1.5)	60.7(3.3)	66.7(12.7)
Scales	12.0(tr)	14.3(2.0)	11.1(1.0)
Other insects	32.0(2.1)	25.0(2.5)	22.2(tr)
Soil/sand	16.0(2.2)	7.1(tr)	22.2(tr)
Sample size	25	28	9

economically beneficial to crops as predators of insect pests.

The economic effects of this squirrel feeding on male flowers of coconut palm is not clear. Yelf (In Williams 1974) noted a significant premature nut fall in the coconut palm due to the feeding activity of rats and flying foxes on the male flowers. But Williams (1974) opined that such feeding activity was unlikely to have any adverse effect on production as there were considerable excess of pollen in each spadix.

Nesting habits.

In all 20 active and one incomplete nest were studied. The nests were round with mean diameter of 22.27±0.66 cm and thickness of 11.85± 0.54 cm (Table 2). The nests weighed 35.0-207.0 g (mean 71.23±6.42 g). Only three of the 30 nests weighed more than 100 g. These three nests had 8-10 unhusked dried arecanuts, which by themselves weighed more than 100 g. The intact nuts probably were collected for their fibrous husks, one of the common nesting materials in the nests of these squirrels.

Male and female squirrels inhabited separate nests. Male nests were used for resting and female nests for sleeping and rearing their young. Of the 29 active nests observed, 11 were of males and 18 females. The mean weights of the nests of male and female squirrels were 58.64 ± 6.28 g and 80.17 ±9.36 g respectively. The difference in their weights was not significant ($P > 0.05$).

All nests were constructed of fibrous materials unlike several other sciurids (Middleton 1931, Layne 1954, Everard 1968, Brown and McGuire 1975, Raspopov and Isakov 1980) which mostly used dried leaves and twigs for

nest construction. The Western Ghats squirrels collected nesting materials from 15 species of trees (Table 3). The fibres of dried leaves of *Agave, Pandanus, Musa,* the crown matrix of the coconut palm, dried fronds and nuts of the arecanut palm and of the bark of *Careya* were commonly used in constructing the nests. The northern palm squirrel. *F. pennanti* is also known to use fibrous plant parts as the common nesting material (Purohit *et al.* 1960).

The nests were found on 14 species of trees (Table 2). Mango, arecanut and Strychnine together supported nearly 50% of the nests. This suggested that these squirrels had some

TABLE 2

OBSERVATIONS ON THE NESTS OF THE WESTERN GHATS SQUIRREL

Nesting tree	Height of nesting tree (m)	Height of nest (m)	Weight of nest (g)	Mean diameter of nest (cm)	Thickness of nest (cm)
Strychnos nuxvomica Linn.	8.0	5.0	84.0	22.0	12.0
	8.0	5.0	100.0	18.0	15.0
	9.0	5.0	58.0	18.5	14.0
	9.0	7.0	49.0	21.5	10.0
	9.0	7.0	49.0	22.5	8.0
	6.0	4.0	73.0	28.5++	12.0
Areca catechu Linn.	7.0	6.0	65.0	25.0	14.0
	10.0	9.0	128.0	●	●
	15.0	14.0	87.0	22.5	16.0++
	20.0	19.0	53.0	19.5	7.0+
Mangifera indica Linn.	30.0	4.5	207.0++	24.0	15.0
	10.0	7.0	59.0	20.5	11.0
	7.0	5.0	70.0	22.5	16.0
	10.0	5.0	37.0	19.5	10.0
	8.0	4.0	35.0+	●	●
Cocos nucifera Linn.	4.0	3.0	67.0	24.5	8.0
	10.0	9.0	126.0	27.5	15.0
	30.0	29.0	81.0	22.5	14.0
Holigarna sp.	10.0	7.0	72.0	21.5	11.0
	8.0	4.0	37.0	21.0	14.0
Borassus flabellifer Linn.	20.0	2.0*	77.0	19.0	14.0
Theobroma cacao Linn.	4.0	2.0	98.0	●	●
Cinnamomum zeylanicum Blume	7.0	5.0	81.0	14.5+	12.0
Pandanus tectorius Soland.	5.0	4.0	38.0	26.5	9.0
Hopea wightiana W. & A.	8.5	7.0	56.0	28.5	12.0
Terminalia sp.	8.0	4.0	51.0	25.0	11.0
Tamarindus indica Linn.	12.0	5.0	44.0	●	●
Sapindus emarginatus Linn.	16.0	12.0	50.0	22.0	8.0
Unidentified tree	4.0	2.5	52.0	23.0	12.0
Building roof	4.0	4.0	53.0	19.0	8.0

+ Minimum ++ Maximum * Built on some epiphytes at 2 m above the ground. ● Measurements could not be taken as the shape of the nest was changed while removing.

TABLE 3

ABUNDANCE (EXPRESSED AS PERCENTAGE IN EACH NEST) AND FREQUENCY (EXPRESSED AS PERCENTAGE OF TOTAL NESTS) OF OCCURRENCE OF NESTING MATERIALS IN THE NESTS OF THE WESTERN GHATS SQUIRREL (N = 30)

Nesting material		Percentage in each nest (Number of nests)						Percentage of nests with this nesting material
Plant species	Parts used	5	5-24	25-49	50-74	75-99	Complete	
Agave sp.	Fibre from dried leaves	1	1	1	0	0	3	20.0
Borassus flabellifer Linn.	Fibre of crown matrix	0	0	0	0	0	1	3.3
Bombax malabaricum DC.	Fibre of the bark	0	3	1	0	0	0	13.3
Musa paradisiaca Linn.	Fibre of the leaf sheath	1	2	4	1	4	2	46.7
	Dried leaves	1	0	0	0	0	0	3.3
Pandanus tectorius Soland.	Fibre of dried leaves	1	1	0	0	1	2	16.7
Theobroma cacao Linn.	Fibre of the bark	0	0	0	0	1	0	3.3
	Beans	0	1	0	0	0	0	3.3
Cocos nucifera Linn.	Fibre of crown matrix	2	2	1	2	0	0	23.3
	Fibre of husk	1	2	0	0	0	0	10.0
	Leaflets	2	0	0	0	0	0	6.7
Areca catechu Linn.	Parts of inflorescence	2	2	2	0	0	0	20.0
	Dried arecanuts	0	2	0	0	0	0	6.7
	Fibre of areca husk	0	3	0	0	0	0	10.0
	Fibre of dried frond	0	2	1	1	2	0	20.0
	Leaflets	1	4	1	0	0	0	20.0
Terminalia sp.	Fibre of the bark	0	0	1	0	0	0	3.3
Careya arborea Roxb.	Fibre of the bark	0	0	2	2	1	1	20.0
Unidentified grass	Complete	0	1	0	0	0	0	3.3
Monstera sp. (root-climber)	Fibre of the vine	0	0	0	1	0	0	3.3
Unidentified climber	Complete	0	1	0	0	0	0	3.3
Unidentified tree	Fibre of the bark	0	1	0	0	0	0	3.3
Jute thread	Complete	0	0	1	0	0	0	3.3

sort of discrimination in selecting trees for nest construction. Selection for nest trees was earlier noticed in certain other squirrels also (Brown and McGuire 1975, Fancy 1980). the branches of the wild trees of the study area were cut and mutilated every year for firewood and leaves for composting. The regrowth on such branches is dense and the squirrels found convenient nesting spots in such branches where the nests are concealed and protected by the leaves.

The nests were built at heights of 2-29 m on trees 4-30 m tall. However, on palms like arecanut and coconut the nests were situated on the crown irrespective of their height. This squirrel, unlike several other species (Allen 1943, Layne 1954), was not observed to build its nests in natural cavities of trees. The northern palm squirrel (Agrawal 1965-'66, Purohit *et al.* 1966) and the European red squirrel, *Sciurus vulgaris* (Raspopov and Isakov 1980) were some of the other squirrels which built their nests on the branches of trees.

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5. REPORT ON THE OCCURRENCE OF THE BROWN SPINY MOUSE, *MUS PLATYTHRIX* BENNETT, 1832 (RODENTIA: MURIDAE) IN WEST BENGAL, INDIA

During a recent mammal survey tour in September 1984, a large-sized white-bellied mouse with bicoloured tail and spiny hair was trapped at Mandalpushkarini near Garhbeta in Midnapore district, West Bengal. It turned out to be an example of the Brown Spiny Mouse, *Mus platythrix* Bennett.

This species occurs within the Indian limits in southern India, Maharashtra, Gujarat, Rajasthan, Madhya Pradesh, east to Pareshnath Hill in Bihar and patches in Kangra (Punjab) to Kumaon (Uttar Pradesh). Out side Indian limits, it occurs in Pakistan, Burma, Sri Lanka and Nepal (Blanford 1891, Ellerman 1961, Ellerman and Morrison-Scott 1966, Biswas and Tiwari 1969, Agrawal and Chakraborty 1971 and Marshall 1977). However, the extant literature does not mention its distribution in Orissa, West Bengal, Sikkim and the north-eastern part of India (Assam, Meghalaya, Arunachal Pradesh, Nagaland, Manipur, Tripura and Mizoram). Hence the present material constitutes the first authentic record of its occurrence in West Bengal.

The details of the specimen are given below. The external measurements were taken in the field. All measurements are according to Ellerman (1961) and given in millimetres.

Material: 1 adult ♂; Z.S.I. Registration Number 21265; in alcohol; Mandalpushkarini, *c* 5 km North of Garhbeta, Midnapore district, West Bengal; 21 September 1984; P. K. Das collector; deposited in the National Zoological Collection of India, housed at the Zoological Survey of India, Calcutta.

Measurements: External — Head and body 110; tail 75; hindfoot 18; ear 16.5. Cranial — Occipitonasal 25.8; condylobasal 24.9; nasal 10.2; palate 14.2; bulla 4.5; molar tooth row 4.4; anterior palatal foramen 5.9; diastema 7.2.

The specimen was trapped outside the kitchen of the Forest Rest House which is surrounded by secondary sal forests. The colour of the soil is red.

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6. THE PHENOMENON OF BAMBOO FLOWERING AND ASSOCIATED INCREASE IN RODENT POPULATION IN MIZORAM

The phenomenon of outbreak of rodent population which is synchronous with flowering of bamboo was investigated in Mizoram. In order to study the activities of rats and their association with different types of vegetation, the rodent infested and bamboo flowering areas were extensively surveyed. Various species of bamboo flowering during the period of study were identified. During the period of flowering of *Bambusa tulda* (1976-79) five major species of wild rats and mice were found occurring in the study area. The most commonly occurring rat was found to be *Rattus rattus brunneusculus*. The population of these rats was apparently high in the 'jhums' (fields) and caused extensive damage to paddy crop. The migration of these rats from 'jhums' to bamboo flowering areas or vice-versa was never observed.

INTRODUCTION

A peculiar phenomenon observed in North-eastern hilly areas of India, namely, Mizoram, parts of Meghalaya, Arunachal Pradesh, Nagaland and Manipur is the periodic mass-flowering and seeding of certain bamboo species which is accompanied by a tremendous increase in the population of certain rodent species. Congregation of millions of rats at the time of bamboo flowering in Arunachal Pradesh was reported by Pareek (1979). Enormous increase in the population of certain rodent species of namely *Nesokia*, *Mus*, *Rattus*,

Golunda, Rhizomys, genera coinciding with bamboo flowering, was reported earlier in other parts of India (Win 1951, Kermode 1952, Chatterjee 1960, Santapau 1962, Nath 1968). Occurrence of such a phenomenon has also been reported from many parts of the world *viz.* Malagasy, Burma, Japan and Brazil (Janzen 1976).

This is a unique biological phenomenon which results in severe famine conditions due to damage of crops by these rodents. In order to explore this phenomenon, detailed study was conducted in Mizoram (Lushai hills) during the years 1976-79, the period of flowering of *Bambusa tulda.*

Study area

Mizoram, a Union Territory, is situated on the eastern border of India between 22.19′ to 24.19′N latitude and 92.16′ to 93.16′E longitude. The land is between Chin Hills (Burma) in the east and south, and Chittagong Hill tracts (Bangladesh and Tripura) in the west. Mizoram has a very variegated hilly terrain. The territory is divided into three districts, namely, Aizawl, Lunglei and Chhimtuipui.

The climate and soil of Mizoram is suitable for growing almost any kind of tropical crop. Though the principal crop is paddy *(Oryza sativa)*, other crops like maize *(Zea mays)*, ginger *(Zingiber officinalis)*, sweetpotato *(Ipomoea batatas)*, turmeric *(Curcuma longa)*, chilli *(Capsicum* sp.), tobacco *(Nicotiana tabacum)*, orange *(Citrus* sp.) and certain vegetables are also grown. One fifth of the area is covered with forest of tropical trees and plants. Thick bamboo forests are in abundance on the low hills and valleys. Shifting 'jhum'* cultivation is widely practised which results in serious destruction of forests. Terrace and wet-land farming has recently been started.

In this region, following the flowering of bamboo, there is a sudden increase in the number of rats which invade the crop fields (specially paddy) in large hordes and cause damage to such an extent that it results in almost famine-like conditions. This was first reported by Elles (1881) in his military report on the Chin-Lushai Hill country. The famines associated with the flowering of *Melocanna bambusoides* (Mautak) and *Bambusa tulda* (Rawthing) are locally known as 'Mautam' and 'Thingtam' respectively. Other minor bamboo species found to be associated with 'Mautam' are *Dendrocalamus longispathus* (Rawnal), *Melocalamus campactiflorus* (Sairil) and *Dendrocalamus sikkimensis* (Rawmi) (Parry 1928, 1932) and with 'Thingtam' are *Melocalamus campactiflorus* (Sairil), *Dendrocalamus longispathus* (Rawnal), *Dendrocalamus sikkimensis* (Rawmi) *Bambusa spinosa* (Phar) and *Pseudostachyum polymorphum* (Chal) (Mohan Ram and Hari Gopal 1981). 'Thingtam' is a famine of lesser magnitude as compared to 'Mautam' and occurs at an interval of approximately 48 years, every 18 years after the occurrence of 'Mautam'. Occurrence of these famines in previous years and the expected one are as follows: 'Thingtam' — 1880-81, 1927-29, 1976-78 and 'Mautam' — 1910-12, 1956-59, 2005 (expected).

Methods

The bamboo flowering areas and the types of rodents and the species responsible for crop

* *Shifting 'jhum' cultivation*: A primitive slash and burn method of cultivation on a slope of hill where a plot of land is cleaned of all its vegetation. The dry leaves and trees trunks are burnt and the land is prepared for sowing. After a few years the old field is discarded and another site on the same hill or a new hill is selected and prepared.

damage in particular and their ecology were studied by undertaking extensive field survey and regularly collecting rat and mice species from the crop fields (jhum and wet-land cultivation areas), bamboo thickets and adjoining forests and tribal settlements in several blocks of Aizawl and Lunglei districts. The rats and mice were collected by extensive digging of burrows and trapping. Collection sites were periodically changed which provided adequate sampling of the entire area within a given time period.

Observations and Conclusions

In the total collection of about 2500 rats and mice, 8 different species were identified, out of which one species of wild rat *Rattus rattus brunneusculus* (Hodgson) constituted the major part of the collection (92.5%). Other 7 rats/mice species *viz. Rattus bowersi mackenziei* (Anderson), *Bandicota* sp., *Cannomys badius badius* (Hodgson), *Vandeleuria oleracea dumeticola* (Hodgson), *Rattus rattus* (Linnaeus), *Rattus nitidus* and *Mus musculus* (Linnaeus) were found to be less significant. The former three species were found to occur in the cultivated areas whereas the latter were mainly in tribal settlements and granaries.

The major species *Rattus rattus brunneusculus*, a serious pest of paddy crop, was invariably collected from paddy fields. It makes simple to complex burrows which contained stored paddy grains and vegetable matters. After harvest, the grain stores of burrows were slowly depleted but paddy husk, chilli, ginger, brinjal, tomato etc. could still be seen. These observations suggest that although the main food of this rodent is rice but when it is not available they start feeding on other vegetable matters and tender shoots of plants. The rat *Rattus bowersi mackenziei* makes complex, deep burrow systems mainly in the paddy fields. They feed on tender shoots of various crop plants and underground vegetables. *Bandicota* sp. is strongly built and fossorial in nature. They were normally found in the low lying areas under wet-land rice cultivation and near marshy stretches and make very complex but shallow burrow systems. Although the population of these rats was found to be insignificant, the damage caused by them to paddy crop was often quite extensive. *Cannomys badius badius* was usually found to occur in sugarcane, arabi, ginger and sweetpotato fields. They were also found to occur in grassy areas near bamboo thickets, bushes and trees. They make complex burrow systems which usually contained ginger and sugarcane pieces. At times, nearly 5-6 kg of these materials were collected from a single burrow. They also feed on other plants, grasses, seeds and fruits. *Vandeleuria oleracea dumeticola* occurs in bushes, trees and bamboo thickets, and feeds on fruits, buds, rice grains etc. Their nests were usually found in tree cavities or between the branches.

Large number of rats *Rattus rattus brunneusculus* were found in paddy fields. They caused extensive damage to paddy crop by lacerating the tillers or cutting them through and feeding on grains. Due to deforestation in preparation of 'jhums' or after harvesting of crops these rats disperse to various other suitable sites but again come back to freshly cultivated 'jhums'. It could be that this short distance movement from the deserted fields and other surrounding areas to new 'jhums' brings their population in sharp focus. The presence of live burrows, paddy husks, damaged panicles, cut leaves and faecal matter on their runways were the signs of their increasing population and activities.

The common bamboo rat *Cannomys badius*

badius which is believed to be the only species causing extensive damage to paddy crop resulting in famine, is not found to be of much significance. This is because their number in these areas was much less (only 3.95% of total collection) and was almost nil in the paddy fields and they inhabit mainly the sugarcane, arabi, ginger, sweetpotato fields and grassy areas near the bamboo thickets.

It seems possible that with the onset of flowering of bamboo, the abundant food supply in the form of bamboo seeds and fruits results in increased biomass. These bamboo seeds and fruits are not only palatable but even preferred more than any other variety of available food items by these rodents and other animals and thus attracts them to flowering areas (Janzen 1976). Despite a constant vigil, no sign of rat migration from 'jhum' to bamboo forest or vice-versa was observed in Mizoram during flowering of *Bambusa tulda.* They mainly inhabited various crop fields especially paddy and showed variation in their number in relation to the crop cycle. Only a few rats were noticed in the forests during this period. This suggests that the extent of bamboo flowering and seed production during these years may not be sufficient enough to attract the rat population. It was observed that only in a very few places in Mizoram, the bamboo flowering resulted in seed formation. Most of the flowers were destroyed by heavy rain and high velocity wind and even the little amount of seeds produced were highly susceptible to various diseases and pests. Therefore, ultimately the food available in the area was negligible and insufficient to account for nomadic behaviour of animals and population explosions but this could be due to the effect of seeds and fruits on reproduction rate of these animals (a possibility which is yet to be confirmed).

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7. GANGETIC DOLPHIN, *PLATANISTA GANGETICA*: OBSERVATIONS ON HABITS AND DISTRIBUTION PATTERN IN NATIONAL CHAMBAL SANCTUARY

(*With two text-figures*)

Based on a preliminary survey conducted for two seasons in 1983-1985 along 570 km of River Chambal a total of about 45 dolphins are estimated to be occurring between Batesura (305 km upstream Yamuna-Chambal confluence) and Pachhnada (total 320 km). The observed density of one adult per about 6.5 km of inhabitated stretch is suspected to be an under estimation because of the strict methods adopted to avoid any possible double counts. Observations made on the feeding behaviour indicated sweeping movement of head through a fish-shoal. Smallest dolphin were sighted during the first week of January. During March-April the adults 'disappeared' from certain stretches perhaps to avoid shallow depth and participate in breeding. On 27-4-84 two dolphins were seen side by side at Tigri Rithaura and believed to be in a courting act. On corroboration it is believed that the gestation period is nine months (April-January) in Chambal. The immediate danger for the resident population of *P. gangeticus* in National Chambal Sanctuary is the decrease in river depth and appearance of sand bars dividing the river course into smaller segments.

Annandale (1912) mentioned that the gharial (*Gavialis gangeticus*, Reptilia, Crocodilia), the soft-shelled turtle (*Trionyx gangeticus*) and the gangetic dolphin (*Platanista gangetica*, Mammalia, Cetacea) had the same range of distribution. Writing of the dolphin, Prater (1965) stated that the species was found in the Ganges, the Brahmaputra, the Indus, and their larger tributaries to the base of hills, and they were also seen in the tidal limits but not in the sea. As has been observed with the accounts on detailed distribution of the gharial, dolphins too have not been studied in river Chambal, a good south-western tributary of the Ganges, almost entirely under the management of the National Chambal Sanctuary since 1978. The occurrence of dolphins in Chambal have not been dealt even by Jones (1982) in his account on the species' present status.

During the course of an ecological study on the gharial commenced in June 1983 dolphins were met almost all along the northern stretch of the river in the sanctuary. Earlier to that, from 1978 both authors while remaining associated with the activities of the sanctuary had taken note of the frequent and easy dolphin sightings. Data collected during 1983-1985 have been analysed in the following to give a preliminary account on the distribution pattern, breeding season, local movements and feeding by dolphins in Chambal.

Methods

On Field-Map sheets the river is marked every five km apart from Pali (Parbati-Chambal confluence) upstream to Bharreh (Chambal-Yamuna confluence), 425 km downstream (Fig. 1). Periods during which different lengths of the river were surveyed are as follows:

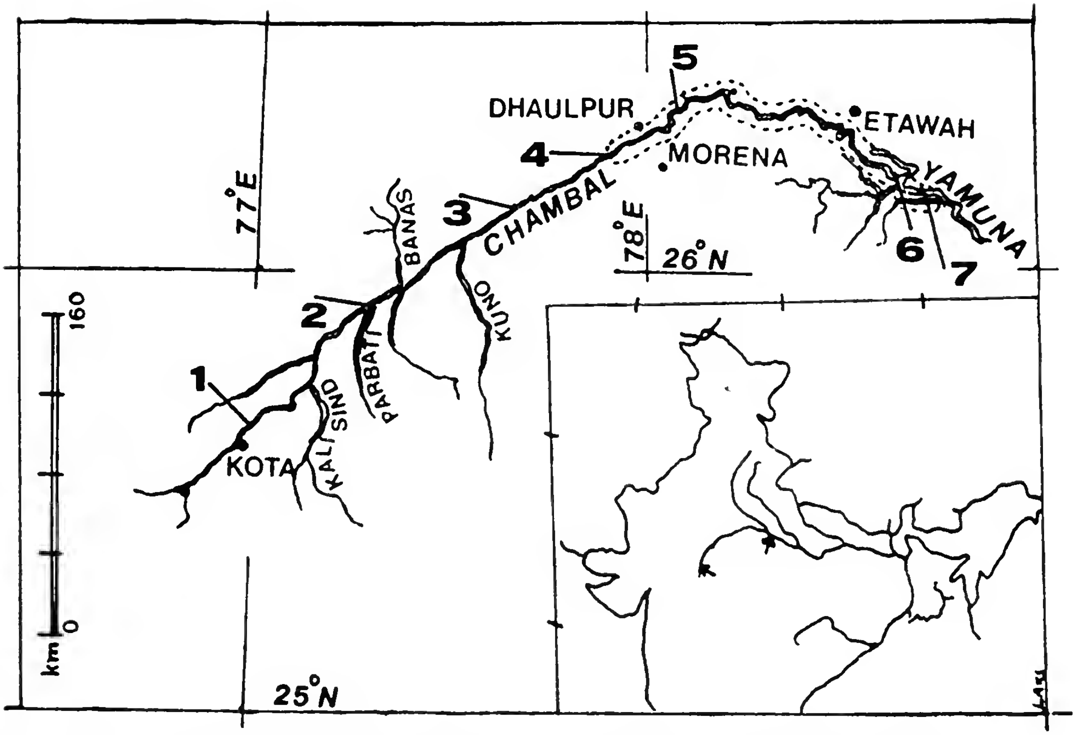

Fig. 1: National Chambal Sanctuary with locations referred to in the text (1, Keshoraipatan; 2, Pali; 3, Rahu ka Gaon; 4, Basai Dang; 5, Pureini; 6. Bharreh; 7, Pachhnada) and occurrence zone (dotted) for *Platanista gangetica.*

Zone — 1: Keshoraipatan (Kota)-Pali: 142 km: Feb./Mar. 1984.

Zone — 2: Pali-Rahu ka gaon: 110 km (0-110 km): Visits to different points from road during 1983-1985 and along the river in Feb.-June 1985.

Zone — 3: Rahu ka gaon—Basai Dang: 60 km (110-170 km): November 1983/March 1984, February 1985.

Zone — 4: Basai Dang-Pureini: 60 km (170-230 km): October 1983,-June 1985.

Zone — 5: Pureini-Bharreh: 195 km (230-425 km): January 84, December 84.

Zone — 6: Bharreh-Pachhnada: (15 km): January 84/December 84.

All survey work, except when otherwise mentioned were conducted from boat or on foot. Zone 1, 2, 3 and 4 are separated from each other by rapids and shallow water for which, in this stretch the river appears continuous only during a high flood (above 20 m). During rest of the period, October through July, Zones 1, 2, 3 and (4-6) are not suitable for cross-zone movements by large deep-dwelling animals like the gharial and dolphins. Therefore, inspite of different dates of survey any overlap in counts between the zones 1/2, 2/3 and 3/4 is ruled out. Zone 4 was the main study area for the original gharial work, therefore, information from this was collected almost daily or at very short intervals.

Dolphin sightings were recorded against the

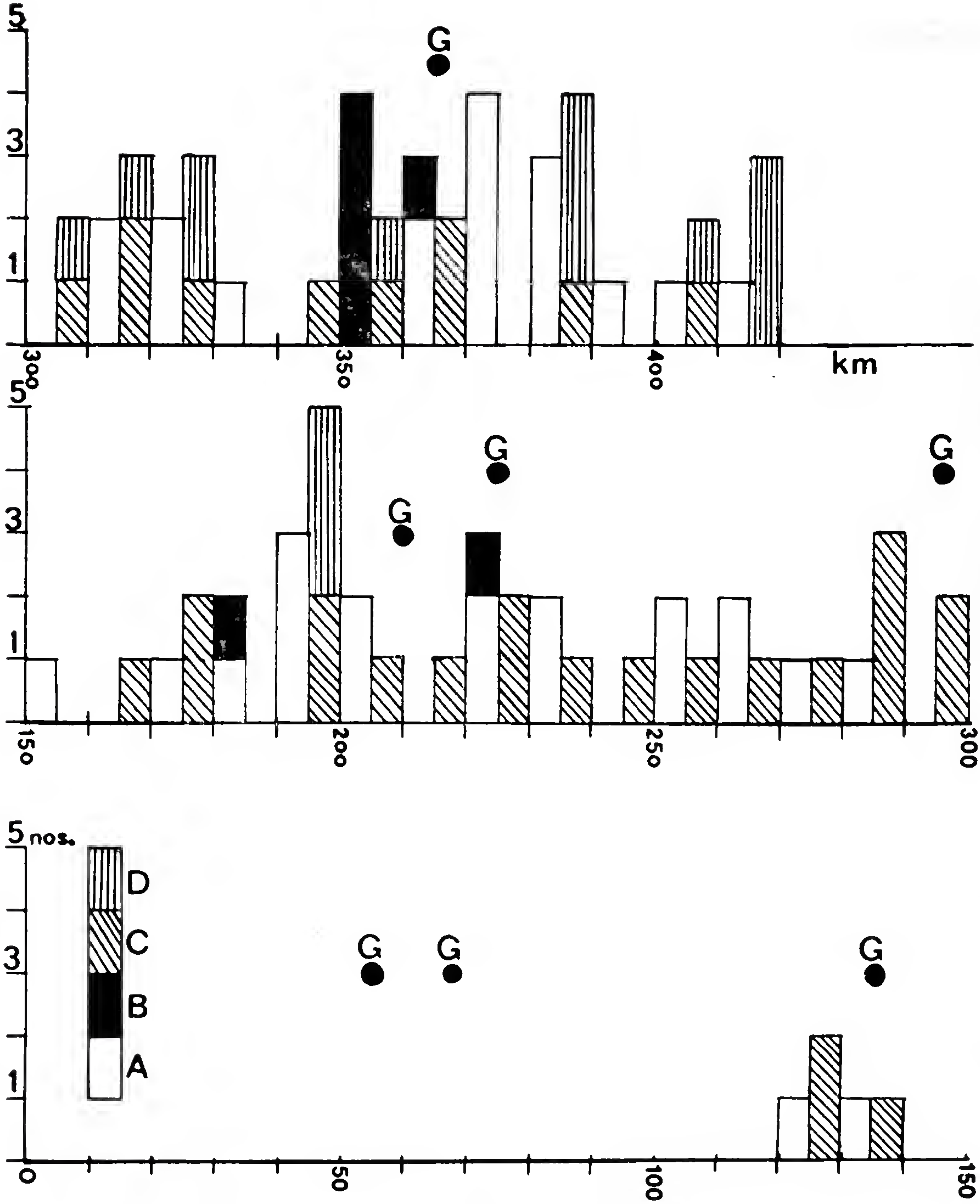

Fig. 2: Comparative data for the 1st year (A & B) and 2nd year (C & D) on the occurrence of dolphin in National Chambal Sanctuary with respect to the gharial nesting sites (G). A and C: sight's for dolphins over 1 m size and B, D: smaller dolphins. 'Zero' point in the scale refers to Pali (Chambal-Parbati confluence).

date on Field-Map sheets. The number of field days for any zone was from a minimum of one during annual surveys to over fifty per year for zone 4. Sightings are presented on the basis of 10-km stretches in Fig. 2. When a dolphin was suspected of having resurfaced ahead of the boat it is shown against the stretch where first sighted. Judged from girth and length, those below a metre length have been considered as young dolphin (Fig. 2, B & D).

Observations

1. *Distribution*

Upstream the point 120 km neither any dolphin was sighted nor a confirmed report received. In downstream, except the stretches 140-150 km and beyond 420 km in all other stretches dolphins were recorded. The river from 170 km downstream is fairly continuous during all seasons of the year. Although dolphins are known to occur downstream 425 km, in Yamuna, extensive fishing activities may be posing a situation of harassment for free movement of the animals. The mean minimum density in the river between Batesura (120 km) and Bharrch (425 km) is one dolphin per every 6.9 km (1st year data) and 6.4 km (2nd year data), with an average of one dolphin per about 6.5 km.

During the first year 7 small (less than 1 m length) and 37 large dolphins were recorded while in the second year 15 small and 32 large were recorded. As the total numbers are closely similar, 44 and 47, error may have developed in the breakups into size groups.

2. *Habit*

There was no definite clue that the dolphins were abundant near important gharial zones (G-gharial nesting site in Fig. 2). Any long stretch of deep water appeared to be most favoured. Based on observations made in Zone-4 (170-230 km), during dry season, particularly March-June, dolphins had disappeared from certain regular places. Two such stretches were near 185 and 200 km.

On 27.4.84 at 1100 hours at 210 km two adults were sighted performing surface-leaps almost touching each other's body. On no other occasion two dolphins were sighted moving so close to each other.

Dolphins in the smallest size groups were sighted at 350-355 km during the first week of January. From a distance these young ones appeared like small fish around 50 cm in length. During mid-March a little larger young one was seen at 180/185 km.

On three occasions dolphins have been seen in shallow water while making sidewise sweeps of the head as shoals of fish appeared greatly disturbed. These observations, considered to be 'feeding' were all recorded between 900-1200 hrs at 210 km, 213 km and 295 km points in respect to Pali.

When we moved by boat fitted with an outboard motor, very seldom does a dolphin surface by the side of the boat. Once (26.1.84) an adult was as close to the boat as 4-5 m, near 225/230 km. During our observations we could not be convinced that a dolphin should surface for breathing after every minute or so of immersion (as stated by Prater 1965). The immersion duration may be well over five minutes.

Discussion

Status:

1. The most recent publication on the status of *P. gangeticus* is by Jones (1982) where he estimates the total population at 4000-5000 including 500-750 in the Ganges proper and

its tributaries. Jones has further mentioned that reliable information was available to him only for rivers in Bangladesh, and he perhaps may have had only a surmise that during summer when Ganges is at its lowest, the species enters "Yamuna as far as Delhi and also enters for a short way all the larger affluents of the main stream".

2. Our study indicates that River Chambal has a resident population of about 45 dolphins in the stretch between Batesura and Bharreh, respectively 120 km and 425 km downstream Chambal-Parbati confluence or upto 325 km upstream Yamuna-Chambal confluence. Although we confirm seasonal local migrations, we do not have any evidence if the dolphins sighted near Delhi (Jones 1982) are population of Yamuna itself or migrants from the Ganges. Yamuna at its confluence with Chambal is very shallow and is reportedly shallower at places in the upstream to hardly permit any movement of dolphins from the Ganges into Yamuna up to Delhi. Instead, the chances of dolphins entering Chambal from Yamuna are greater.

3. Gangetic dolphin is without doubt a rarer species now than it was some years back. LAKS, who worked along the River Mahanadi of Orissa for several years had never sighted a dolphin (called *Susumár* in Oriya) although definite evidences were collected that the mammal was very common during 1950s in the lower Mahanadi upstream of the tidal limits.

4. In all probability, the number of dolphins recorded in the present study are underestimated figures because too much restraint seems to have been adopted in order to avoid double counts. In such a situation since the areas of occurrence are clearly identified the density of one dolphin for every 6.5 km will be improved upon only if they are occurring in groups. There is no clue to check the trend in the population that exists in Chambal which is over a thousand km upstream the tidal limits of Bay of Bengal. Talking to fishermen near Chambal-Yamuna confluence it was ascertained that they cannot remember if a dolphin was anytime caught in fishing net although restraint in movement may have been imposed due to netting activities. The information is probably true dolphins are known to have an extra-sensory mode of locating obstacles through echo-location (Singh & Behura 1977). Net capture of dolphins in the plains and deltas may be dependent on number and types of nets, density of the dolphin population and other aquatic conditions that confuse echo-location. As the subject warrants a detailed scrutiny, it may be mentioned that Bilgrami (1983) states from his study along Patna-Farakka, a stretch of 350 km of the Ganges, that the dolphin "is being indiscriminately killed for extraction of oil". Jones (1982) on the other hand stated that the species was in no immediate danger of extermination and emphasised the need for more study. We feel that the shrinkage of inhabitable stretches of the river could be the immediate danger for the species. The danger of shallowing down of the rivers and silting of dams and river beds have already been realised. Therefore, expressing their cause of concern, dolphin biologists should give support to afforestation programmes in the catchment areas, and measures for control and prevention of chemical pollution of the rivers.

Breeding:

The 'disappearance' of dolphins from certain stretches may be in order to avoid shallow depth and/or to move and join some other dolphin or group for breeding. Prater (1965) mentioned that "one or rarely two young are born between April and July after a period

of gestation of about eight to nine months". If our observation of side-by-side leaping of two adults is related to courting in April and that the young ones are born during or before January then the gestation period for dolphins in Chambal appear to be the same as stated by Prater, i.e., nine months (April-January). The disagreement over the exact months of the birth of young could be due to a difference in the area from where births have been reported. Prater's account seem to be on populations down in the plains just above the tidal limits. It is also to be expected with a population like that of Chambal, that the reproductive cycle has to be precisely seasonal because of the limitations by the changes in the river conditions and perhaps a simultaneous structural change in the food resource too. These features are less restraining in the lower limits of a river close to tidal limits.

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8. YELLOW BITTERN NESTING, A NEW RECORD FOR POONA

The TELCO complex at Pimpri, Poona, has within its premises a fair-sized lake surrounded by thick reed beds and a number of large and medium sized trees. The entire area being protected, makes an ideal refuge for a number of birds.

On September 2nd, 1981, Mr. Shrikant Ingalhalikar, Mr. Avadhut Bapat and I visited the lake and counted 34 bird species that morning. One bird escaped our identification and was later confirmed as the female Yellow Bittern (*Ixobrychus sinensis*).

On August 18th, 1983, a cloudy overcast morning, Mr. Ajit Kulkarni, Mr. Avadhut Bapat and I visited the lake again and spotted a pair of these bitterns. As we watched, the female silently moving through the reeds, approached three chicks hidden in a well concealed nest. After the female left, I cautiously approached the nest and took some photo-

graphs of the chicks and the nest. The latter was beautifully camouflaged in a tangle of reeds about three feet from the water's surface, the depth of the water was a foot and a half. The reeds had been bent down and criss-crossed to form the base of the nest and then a sort of a roof. One of the chicks suddenly dropped into the water and confidently paddled away to the safety of some reeds.

Whilst photographing the nest, the male silently returned. He clenched the reeds with both feet, some distance away from the nest, and swayed his head and neck repeatedly from left to right, all the while uttering a low croaking sound. The recorded call of this bird is a "kaka-kakak" (Ali & Ripley 1983). Both the wings were held down and open adding perfectly to his act to draw my attention away from the nest. This bird shares the lake with birds like the Chestnut Bittern, Brown Crake, Pheasant Tailed Jacana, Spotbill Duck (nesting),

The same morning, we saw a juvenile Night Heron but were unable to locate any adults or the nest.

Apparently information about the Yellow Bittern in Maharashtra is quite scanty and I believe that this is probably the first record of this bird and its nesting in Poona, the HANDBOOK describing its distribution as throughout India, from the Indus, east to Assam and from Nepal south to Kerala.

I am grateful to Mr. M. D. Sharma, Chief Horticulturist of the TELCO, Pimpri for his permission and help.

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9. SIGHT RECORD OF THE BLACK CRESTED BAZA (*AVICEDA LEUPHOTES*) IN MADRAS

It was a hot and sultry morning on the 13th January 1983, and I was walking down the trail running across the Guindy National Park on the outskirts of Madras city. The time was just past 10.00 a.m. and the air was still with scarcely any breeze. I noticed a pair of small black hawks circling just above the tree-line a little ahead of me. I watched them with my 10 x 35 binoculars and realised that they were Black Crested Bazas. The birds wheeled about overhead for several seconds giving me ample opportunities to take down their details. The coal black underparts with the pale markings on the underwing, along with the contrasting white breast band renders this species quite unmistakable. When the birds banked in the air, I was also able to get glimpses of the white band on the trailing edge of the upperwing. Eventually they started soaring higher and higher till I lost sight of them behind some lofty trees.

According to Ali & Ripley (1968) the Black Crested Baza shows a curious widely discontinuous Indo-Malayan distribution. Two

far flung resident populations are said to exist, one in the East Himalayan and South-East Asian regions and the other in South-West India. No mention is made about their occurrence on the east coast.

The present sighting is of interest considering the fact that there are few records of the hawk in the eastern seaboard (see Sugathan 1983). It is presumed that the birds which were noted in Madras, and also those previously recorded elsewhere down the coast, were members of the northern population on their way from or to Sri Lanka.

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10. THE BLACK EAGLE *ICTINAETUS MALAYENSIS* TEMM. AND LAUG AT SAWAI MADHOPUR (RAJASTHAN)

I was camping at Sawai Madhopur and on December, 17th 1983 while proceeding to the Ranthambhore National Park I saw an adult Black Eagle gliding close to the roadside before approaching the main park on the periphery of the thorn forest. The bird was so close to me that I had no difficulty identifying the bird, having seen it frequently before but never in this part of India. Its upturned wing tips, dark blackish-grey plumage, the mottled upper tail coverts, are distinctive characters and well seen in Plate 56, of INDIAN HILL BIRDS by Salim Ali (1949). As I could not find reference of this eagles' distribution to cover the area where it was seen or in the Aravallis, the range of this bird may be considered extended by this sight record.

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11. ON THE PARENTAL CARE OF YELLOW-WATTLED LAPWING *VANELLUS MALABARICUS*

From March 15th 1984 for more than a week, in the morning at about 9-50, on my way from my quarters to the Department of Zoology, I used to see a pair (at times single) of Yellow-wattled lapwing *Vanellus malabaricus,* calling and moving around a nursery school, adjacent residential quarters and the University press buildings. For a few days, I

did not pay any special attention to these birds as the Yellow-wattled lapwing is a common, resident and nesting bird in the campus.

On 29th March 1984 at 4.30 p.m. when I happened to walk close to the pair they appeared to be extremely agitated. They were flying in a circle very close to a termitarium, uttering contact calls. A closer examination of the area revealed two chicks following the adult lapwings. The chicks were seen voraciously feeding on termites exposed from earthern runways covering dry vegetation scratched open by the adult bird. It appeared that the adults were the parents.

Whenever I approached close to the chicks, the parent birds voiced 'warning calls' and the chicks abruptly squatted on the ground. The colour of the chicks matched the ground to perfection. I picked up the chicks in my hand to examine them, and both the parent birds, one after the other agitatedly flew around me and almost dashed at me several times. This continued for 10 minutes. As I continued to keep the chicks in my hand, the parent birds left the scene for more than five minutes. I carefully placed the chicks on the ground among dry leaves. Every time the nursery school children moved close to the chicks, the adults drew near the children.

It appears to me that the birds were accustomed to human presence and preferred to nest, to feed and care the chicks near human dwellings and places of human activity. Nesting and caring of the chicks at this unusual site must perhaps have been providing protection from predators such as Common Mongoose, stray dogs, cats, crows, rat- snakes, etc.

By nesting and breeding near human habitations, are the lapwings trying to take advantage of this habit of nesting for the protection of their chicks from predatory animals which keep away from human habitations? There are many uninhabited areas on the campus where lapwings do nest but as far as I know, they meet with little breeding success.

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June 12, 1984.

12. LARGE GREY SHRIKE KILLING A SNAKE

According to Ali & Ripley (1969), the food of the Large Grey Shrike (*Lanius excubitor*) is insects, young rodents and young or sickly birds. On 10 December 1982 at Karera, District Shivpuri, Madhya Pradesh, we found a 25 cm long Saw-scaled Viper (*Echis carinatus*) on the food larder of a Grey Shrike on an *Acacia leucophloea* bush. The bird flew away when we went near the bush, leaving the still-living snake hanging from a thorn. Lorber (1982) has seen the African Boubou Shrike (*Laniarius aethiopicus*), "catching a small grey snake about 20 cm long and beat it to death."

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Bombay-400 023,
May 21, 1984.

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13. A BIRD SITTING ON A FLYING BIRD

On the morning of 8 January 1984, we were surveying the grasslands of the Velavadar National Park in Gujarat. At 0915 hours, we saw a drongo (*Dicrurus adsimilis*) chasing a short-toed eagle (*Circaetus gallicus*). The drongo was repeatedly attacking the head of the eagle and the visibly annoyed raptor was trying to outfly the persistent drongo. Thrice, the drongo momentarily sat on the back of the flying eagle. Twice the eagle looked back when the drongo sat on it. When the drongo sat a third time, the eagle suddenly ascended sharply and went higher and higher while the drongo returned to the ground.

The second author has seen a crow (*Corvus splendens*) worrying a white backed vulture (*Gyps bengalensis*) near Dahisar, Bombay in March 1982. The Vulture was sitting on top of a *Ficus benghalensis* tree when a crow alighted on its back. The startled vulture immediately took flight downhill chased by the same crow. Hardly did the vulture catch a thermal current when the crow again landed on its back, but was at once shaken off when the Vulture dived to get rid of it.

BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE,
SHAHEED BHAGAT SINGH ROAD,
BOMBAY-400 023,
May 21, 1984.

ASAD R. RAHMANI
CARL D'SILVA

14. LONGTAILED MINIVET RECORD IN SAURASHTRA

While bird-watching a Baybacked Shrike in front of my house in a *Cassia javanica* tree, I noticed another similar sized bird perched on top of the tree. Looking through my binoculars I noticed it was a female Longtailed Minivet (*Pericrocotus ethologus*) with the yellow wing bar conspicuous. It was strangely a solitary bird and probably a vagrant as I have never seen this species in Saurashtra but it may occur sometimes. The bird was seen on 23.12.1982 in the afternoon and flew into the Victoria Park, across the road. The Park owing to the recent Cyclonic rains was looking green as it is in August with the scrub and other trees in leaf and flower, most unusual for this December season, with all kinds of Warblers and Chiff-Chaffs still quite active feeding.

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January 4, 1983.

K. S. DHARMAKUMARSINHJI

15. "BLIND" OR "CLOSED" NESTS OF BAYA WEAVERBIRD

(*With a plate*)

Introduction

Erach K. Bharucha (1983) recently recorded an unusual behaviour of a female purple-rumped sunbird (*Nectarinia zeylanica* Linn.) which sealed off the entrance to its nest, thus not leaving any opening for the bird to reach the brood chamber. Bharucha considered this behaviour of the sunbird as nest building error. I came across two completely closed nests of baya weaverbird (*Ploceus philippinus* Linn.) which are briefly described here. One notices considerable variation in the form and structure of baya weaverbird nests. In many baya weaver colonies, one comes across many multi-storeyed nests towards the end of the breeding season. The male baya, the sole builder of the nests, has strong territorial control. Therefore, the individual nests of a multi-storeyed nest are the making of the same male builder. It usually seals off the entrance tube of completed nests when the fledgelings vacate them, and attaches a new nest at the terminus of the entrance sleeve. Even though such sealed nests have to be regarded as normal for baya weaverbird, the two cases of nests being reported here were fully closed at an early stage, much before the nests could be selected by the females.

Abnormal nests of baya weaverbird

The abnormal nest of purplerumped sunbird reported by Bharucha was 'closed all round like a deflated balloon. There was no attempt at a projecting porch either. The pendent nature was basically like a normal nest, but it was not fully expanded like a correctly designed one'. One of the abnormal nests of baya weaverbird (Plate I, 2) somewhat resembled the closed nest of the sunbird by not possessing any opening for the bird to reach the interior chamber. The second nest (Plate I, 3) on the other hand is solid which was sealed off at a much earlier stage in its construction.

Although a typical nest of the baya is retort-shaped and dangling, and woven with strips of palm leaves and grass blades, considerable variation in the form, size and in the manner of weaving them were recorded among others by Ambedkar (1964, 1980) and Davis (1971). Such variation in the nest structure are brought about by factors such as the overcrowdedness of nests in colonies, the result of simultaneous damage to several nests due to wind and cyclonic conditions, and the prevalence of efficient males capable of weaving very smart nests. The incompetence and lack of skill in some adult males as well as the lack of knowledge in nest-building by sub-adult males also lead to great variation in the form and structure of baya nests. Another frequent variation brought about among baya nests is the multi-storeyed nests (Plate I, 1) which are the making of some extra smart males who could weave about ten nests during one breeding season and provide female occupants for each of them. Multi-storeyed nests are brought about by sealing off the entrance tube of completed nest and building new ones below it. However, such nests, though not very uncommon, are different from the unique 'closed nests' seen in figures 2-4. The incomplete nest built on a *Zizyphus jujuba* tree (Plate I, 2) was located near Pune (Maharashtra State). The nest is in the 'helmet' stage, but it lacks

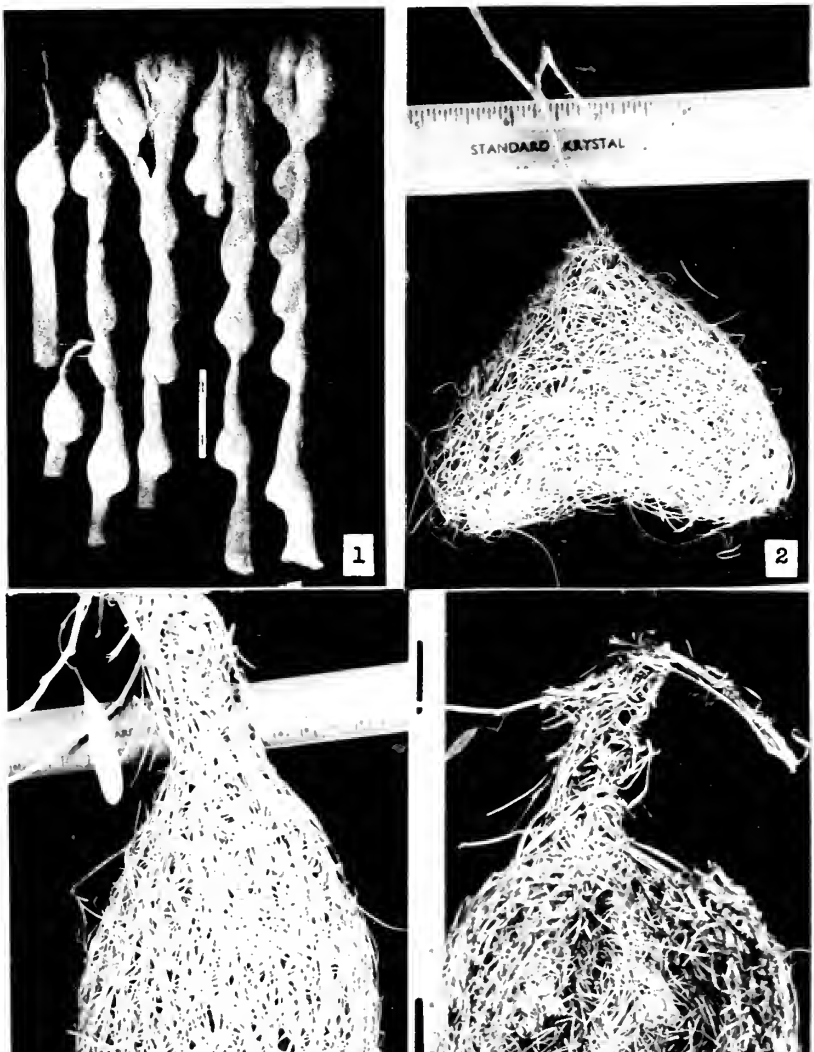

Fig. 1. Normal complete nest of baya weaverbird (bottom left) compared with many multi-storeyed and other unusual nests. Fig. 2. Baya nest from Pune, closed fully at an early stage of construction. Fig. 3. A club-shaped closed nest of baya from Karnal (Haryana State). There is neither an entrance tube nor any opening for the bird to enter the nest. Fig. 4. Inner details of nest in Fig. 3. This nest, to begin with, was woven the usual way providing an egg-chamber and a sleeve. Mud blobs are also seen at two positions in the egg-chamber.

the usual two openings separated by a narrow bridge. Also there is no dome or cavity in it. The dome has been filled with fibre and so it has become solid. The fibre used for weaving this nest was of sugarcane leaf strips. The solid nature of the nest was verified by disecting it out. Also there was no trace of any dung or mud blobs seen inside as is noticed in several nests of baya (Davis 1972). Usually, the lower margin of an incomplete nest contains many partially woven and loosely hanging fibres. But in this nest, the full length of the fibres has been carefully woven and the nest made compact and solid.

Plate I, 3 shows another closed nest of baya weaverbird collected from near Karnal (Haryana State) in 1960. This nest was hanging on a sisham tree (*Dalbergia sissoo*) which could be recognised by the presence of a dry pod attached to the shoot. The nest looked fairly fresh when examined in February which was almost the end of the breeding season for baya in and around Haryana region. From the elegant manner the nest has been woven, the closed nest seems to be the work of an experienced and efficient male. The slightly reduced size of the nest and the lack of an entrance hole attracted my attention, and so, the nest was collected from the unarmed sisham and examined at close range. The fibre used for weaving this nest was also that of sugarcane. But the nest in Plate I, 2 from Pune was more elegant, even though woven with sugarcane leaf fibre, because this builder was able to prepare much thinner strips and weave them more elegantly. Baya in different regions are found to weave the same nesting material with different effect and so, the quailty and appearance of the nests differ considerably. For example, the bird in West Bengal weaves with unstripped paddy straw resulting in crude nests while rice leaf blades are stripped into fine strands and woven elegantly by the male baya nesting around Pune. Incidentally, the birds of West Bengal rectify the deficiency partially by cementing their nests with liberal loads of mud blobs and/or cowdung. How birds of different regions within India select different trees for nesting, gather fibre from different species of plants for building nests and weave nests resulting in great variation in appearance and quality have been described (Davis 1974).

Curiosity prompted me to cut open the nest. The inner details resembled those of a normal nest showing a hood and a narrow bridge which separates the mouth into two openings, one to be completed as the brood chamber and the other to be built as the entrance tube. More striking is that the interior is cemented with mud blobs at two locations on the dome of the brood chamber (Plate I, 4). The presence of mud blobs and the nest having built very strongly only indicate that the nest was worthy of being used by a female for successful rearing of young ones. What prompted the builder to close the nest is not clear. Since the nest was built almost at the very end of the breeding season, it is presumed the male might have waited for a few days for the arrival of a prospective female. But as there was no female available any more coming in search of a mate and a nest, the male might have deserted the nest. But instead of simply discarding an incomplete nest at a stage when two openings are still maintained, the male baya taking the pains to seal the nest fully into a club-shaped, blind nest is difficult to explain. This act of sealing the nest cannot be regarded as absent-mindedness or carelessness. Could it be a playful exercise as the bird had no serious occupation of either enticing a female or providing a strong nest for her.

Weaverbird watchers are aware that in very

active colonies where nesting sites are limited, the male seals off the entrance tube of its nest as soon as the fledgelings leave the nest. Often a fresh nest is built below the sealed entrance tube and made ready for occupation by another female. Thus, the more capable males who can weave efficient nests which are selected more quickly by females, will have many nests hung one beneath another. A few such multi-storeyed nests are shown in Plate I, 1. In rare cases when a mother nursing her chicks dies, and another female is waiting to select a nest, the male quickly seals off the mouth of the nest having the chicks and build a new nest for the waiting female. The male, therefore, seems to have the least concern for the chicks through his one-time mate. The ill-fated chicks meet with starvation death. Thus, the male baya's instinct for building a nest, that too, an efficient one is very powerful indeed. That is why the male cuts down very old nests and those that are not selected by a female for a long time. The bird also laboriously clips off with its beak those nests that are tossed away by wind and held at inconvenient angles. But they are never known to close completely a partially woven nest.

Summary

Two 'closed' or 'blind' nests of baya weaver-bird are reported, one from Pune which is over 1,500 km away from Karnal where the second nest was located. The nests, though incomplete, were woven very strongly and elegantly and so, deserting them could be the non-availability of females coming in search of a nest. Normally nests at the end of the breeding season or those that are not very efficiently-built are simply deserted which will continue to display two openings at the bottom. Thus, the male baya spending some time in sealing off these abnormal nests could be regarded as a sign of playful occupation.

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August 7, 1984.

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16. USE OF WET DUNG IN EGG CHAMBER OF HALF BUILT NEST BY THE BLACK THROATED WEAVER BIRD

(*With three text-figures*)

If we examine nests of *Ploceus philippinus* and other species of the same genus, we find blobs of mud almost invariably struck inside the 'dome' presumably for strengthening the fabric but whose real purpose remains equivocal (Ali, S. & Ripley, S. D.: HANDBOOK Vol. 10, p. 90).

My observations on the nests of *P. benghalensis* showed that a large number of half built nests (95%) had a plastering of wet dung inside their egg chamber. Completed nests of *P. benghalensis* hardly ever have dung inside their egg chamber. The deposition of dung may occur on the roof of the nest or on the outer walls.

Half built nests of *P. benghalensis* observed before noon had fresh yellow (sometimes pink or orange) ornaments like the inflorescence flower petals and pieces of rind of yellow fruits on the wet deposition of dung. Such type of ornamentation is very commonly used by the male of the black-throated weaver. They use the following kinds of beautifying materials. (Table 1).

TABLE 1

LIST OF ORNAMENTALS

Plants providing ornaments	Kind of ornament	Colour of ornament	
Lantana sp.	Flowers or/and Petal	Yellow to orange	
Lagerstroemia indica (?)	Petals	Pink	
Acacia nilotica	Inflorescence	Yellow	
Cucumis melo var. *momordica*	Flowers	Yellow	Flowers only used.
Momordica dioica	Flowers	Light Yellow	Flowers only used.
	Pieces of rind of ripe Fruit	Yellow to Orange	

Collection and implantation of yellow flowers etc. is done only by the male. It is interesting that only fresh floral material plucked from plants is used in ornamentation. Damaged flowers, floral buds, old and decaying floral materials are not used. Selection in plucking can be seen in the case of *Cucumis melo* var. *momordica* and *Momordica dioica.* Both these plants possess separate male and female flowers on the same plant, but only male flowers are taken by the blackthroated weaver for its nest. Generally in the case of small flowers like *Lantana*, *Cucumis melo* var. *momordica*, and *Momordica dioica* a whole

flower is used as a unit while in case of comparatively big flowers like *Lagerstroemia* sp. a petal is used as a unit.

Male flowers are selected because they have a long pedicel while the female flowers possess a comparatively short pedicel due to the presence of an inferior ovary. The long pedicel of the male flower helps the bird to hold it in its bill easily while it is not easy in case of female flowers. In other words the male flower is easily plucked while due to the massive inferior ovary, the female flowers are unwieldy.

The pedicel of the male flowers of *M. dioica* is broken by the bird just between the calyx and the bracteole. Many stumps of pedicels with bracteoles can be seen on plants. Sometimes stumps can be seen in a regular sequence on one branch, indicating that all the flowers were taken by the same(?) male bird (see Fig. 1).

a way that their pedicels rests in the wet dung. This situation of pedicel is very useful for lasting freshness because the pedicel sucks up water from the wet dung. Many flowers are kept upside down also. Drying dung releases moisture hence new layers of dung are deposited by birds every day, generally before noon.

Like other male weaver birds, male black-throated weaver birds are polygamous. Every male wants to win more and more wives. During the 'helmet' stage of nests, females visit the half built nests to prospect for suitable nests and all the while the builders sing, cling to the nest and flutter to advertise themselves. There are three ways by which the male attracts the female:

(1) The attractive golden yellow crown.

(2) Singing, clinging to and fluttering and flapping on the nest.

(3) Ornamentation of nest with yellow flowers embedded in wet dung.

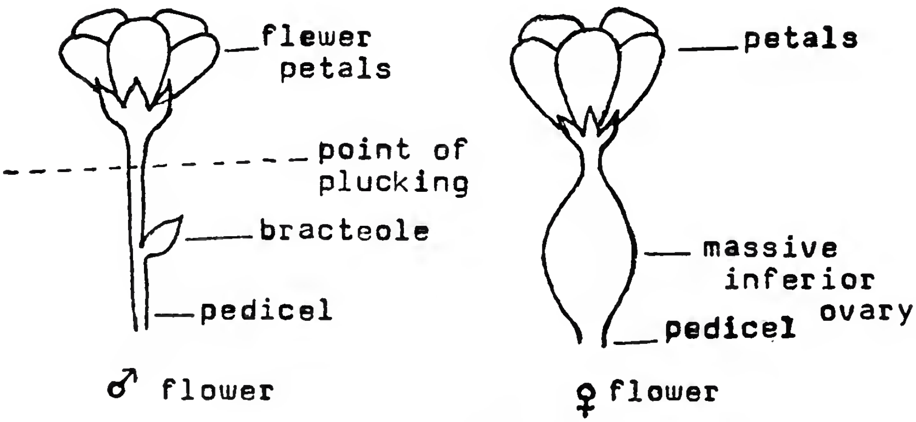


Fig. 1. ♂ & ♀ flowers of *M. dioica*.

The plucking of flowers and their implantation may continue for 2 to 5 days. Generally flowers are implanted before noon every day (Before noon young, fresh and opened flowers become available very easily). The owner of each half built nest keeps the flowers in such

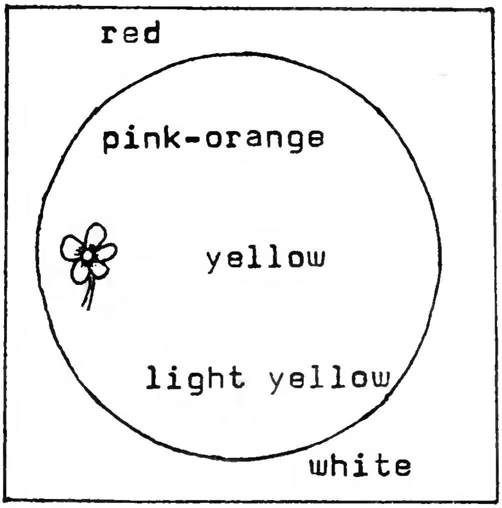
The ornamentation with yellow flowers is very important and this is impossible without wet dung. The main functions of the dung are as follows:

(i) It provides a suitable base. In wet con-

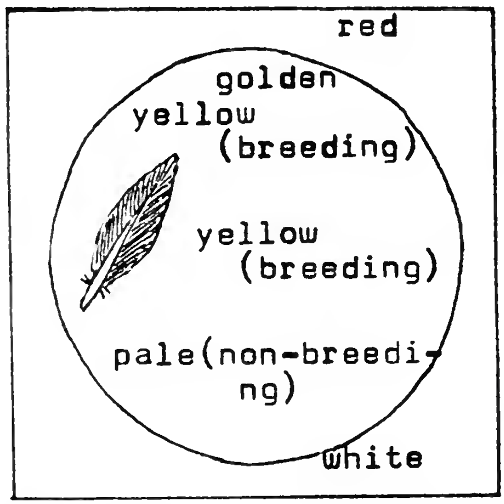
TABLE 2

BREEDING AND NON-BREEDING PLUMAGE OF WEAVERS

Name of spp.	Parts of body where colour change occurs	Colour in non-breeding period	Colour in breeding period
	Crown	Brown	Yellow
P. philippinus	Breast	Buff	Yellow
	Crown	Pale	Yellow
P. megarhynchus	Throat	Pale	Yellow
	Breast	Pale-fulvous	Yellow
P. manyar	Crown	Dark-Brown	Bright Yellow
P. benghalensis	Crown	Dark-Brown	Brilliant golden Yellow



Encircled colour range is liked by weaver birds. Colours which are situated outside the circle not liked by females. We can see orange and yellow coloured flowers of *Lantana* in a half built nest but no red and white flowers of same plant occurs in nests.



Encircled feather colours can be seen among weaver birds. Colours out side the circle not assumed by male birds in breeding period.

Fig. 2. Similarity between colours of flowers inside egg chamber and breeding plumage of weaver birds.

dition it is so loose that insertion of pedicels of flowers is very easy.

(ii) It acts as an adhesive. When flowers are kept upside down their petals are held firmly, and they do not fall off.

(iii) The most important purpose of the wet dung is the supply of water through the inserted pedicels for lasting freshness.

(iv) Moisture, which comes from drying dung, collects inside egg chamber which helps in keeping flowers fresh (Due to the dung the relative humidity remains higher in egg chamber than outside the nest).

It is interesting to examine the significance of the use of yellow coloured flowers or its close variant colours. Before solving this problem we must examine the breeding and non-breeding plumage of the male of the four Indian Species of weaver birds. (Table 2).

Table 2 clearly indicates that feathers of certain areas of the body become yellow during the breeding season in the male but not in the female. It is a well known fact that attractive coloration of male birds is associated with complex sexual behaviour which helps to attract and win the female. The same is the situation here the female weaver is attracted towards the yellow plumage of the males. So to increase its attractiveness the male implants yellow coloured floral parts to invite and attract the inspecting females to its half built nest. (See fig. 2).

Once a nest is accepted by a female, the flowers and dung are removed by the male with its bill completely or partially. Dung, left behind in the egg chamber is covered by new layers of strips and the bird proceeds to complete the nest for the female. In a completed nest, the earlier deposited dung may occur towards the roof of the egg chamber between strips but not in the cavity of the egg chamber.

If a half built (Fig. 3) decorated nest is not accepted by any female, the male leaves it as such and proceeds to make a new nest.

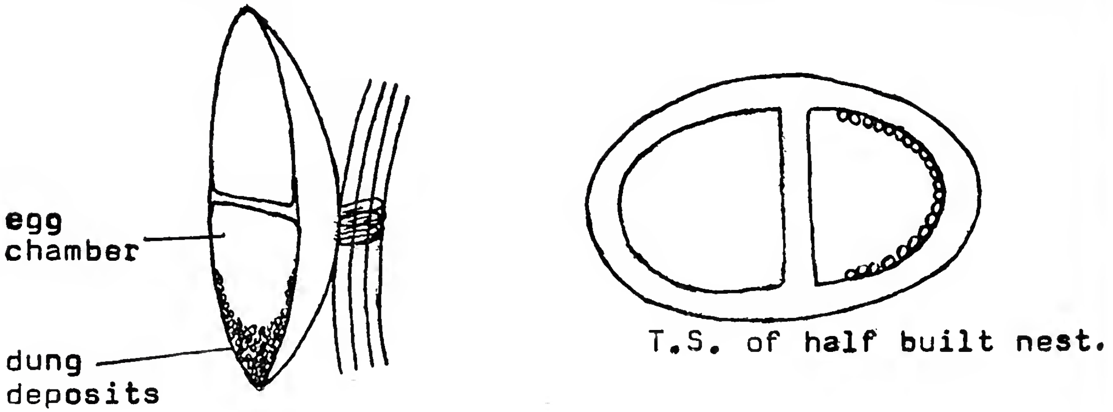


Fig. 3. A half built nest and its T. S.

ACKNOWLEDGEMENT

I am grateful to Dr. Sálim Ali for providing necessary guidance and for going through my notes.

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17. PATTERNS OF DEPOSITION OF MUD INSIDE THE EGG CHAMBER OF THE HALF BUILT NEST OF *PLOCEUS PHILIPPINUS* AND *P. BENGHALENSIS*

(*With five text-figures*)

If we examine the half built nests of *Ploceus philippinus* and *P. benghalensis,* we find deposition of Mud or/and dung inside the egg chamber of the nest. Patterns of deposition

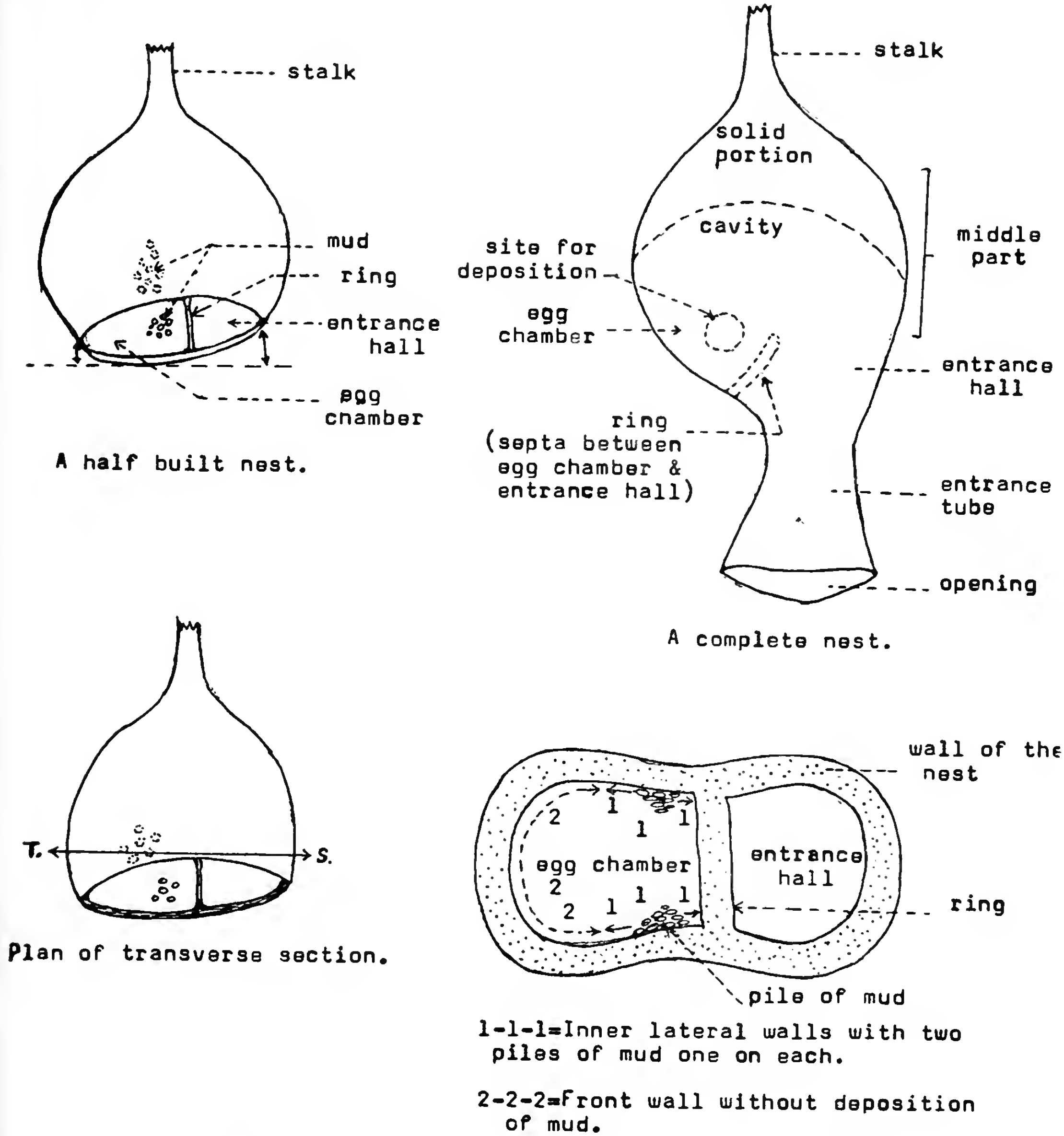


Fig. 1. Patterns of deposition shown in T. S. of the nest of *Ploceus philippinus.*

are different in both the species. Generally two big piles of mud are seen on both the inner lateral walls of the half built nest of *P. philippinus*. Some times, many small piles may occur on both the inner lateral walls of the egg-chamber, instead of two big piles occasionally either one or both the inner lateral wall may be empty. The front wall of the eggchamber of the half built nest remains unoccupied in the case of *P. philippinus*. (See fig. 1).

Deposition pattern adopted by *P. benghalensis* is different in two ways:

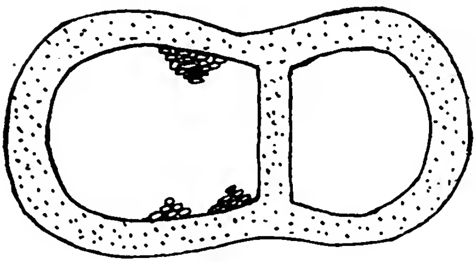
(1) Along with both the inner lateral walls of the half built nest, front wall of the nest is also used for deposition.

(2) It collects the mud in a blob and not in two or more piles.

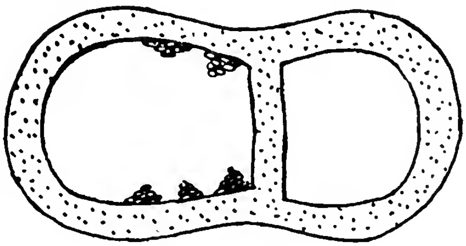
Although male *P. benghalensis* may use all the three inner walls of the eggchamber but sometimes it leaves one or two or all the three walls unused. (See fig. 2).

Now the question arises, why *P. philippinus* leaves the inner front wall of the half built nest unused while *P. benghalensis* uses it? Answer of this problem is hidden in the dimensions of the nest of both the species.

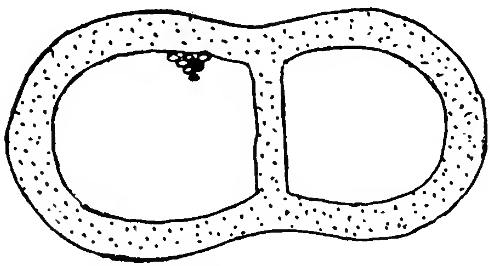
If we study T. S. of the middle part of the nest of *P. philippinus*, we find that it is not circular while T. S. of the nest of *P. benghalensis* taken from the same topography of the



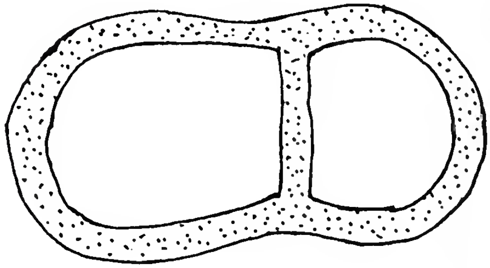
One big pile and many amall piles.



Many small piles on both the inner lateral walls of the egg chamber.



One wall empty.



Both the walls are empty.

Fig. 1. (continued).

middle part of the nest, looks more or less circular. (See fig. 3).

Dimensions of the middle part of the nest of *P. philippinus* are larger than that of *P. benghalensis.* Circumference of the middle part of the nest of the former species is larger than the latter species. The radius of a circular section is directly related to its circumference. If radius is small, circumference will be lesser.

The middle portion of the nest of *P. benghalensis* looks more or less circular while the nests of *P. philippinus* are not so; but they are laterally compressed and looks like a capsule. The two radii at right angle to each other in the

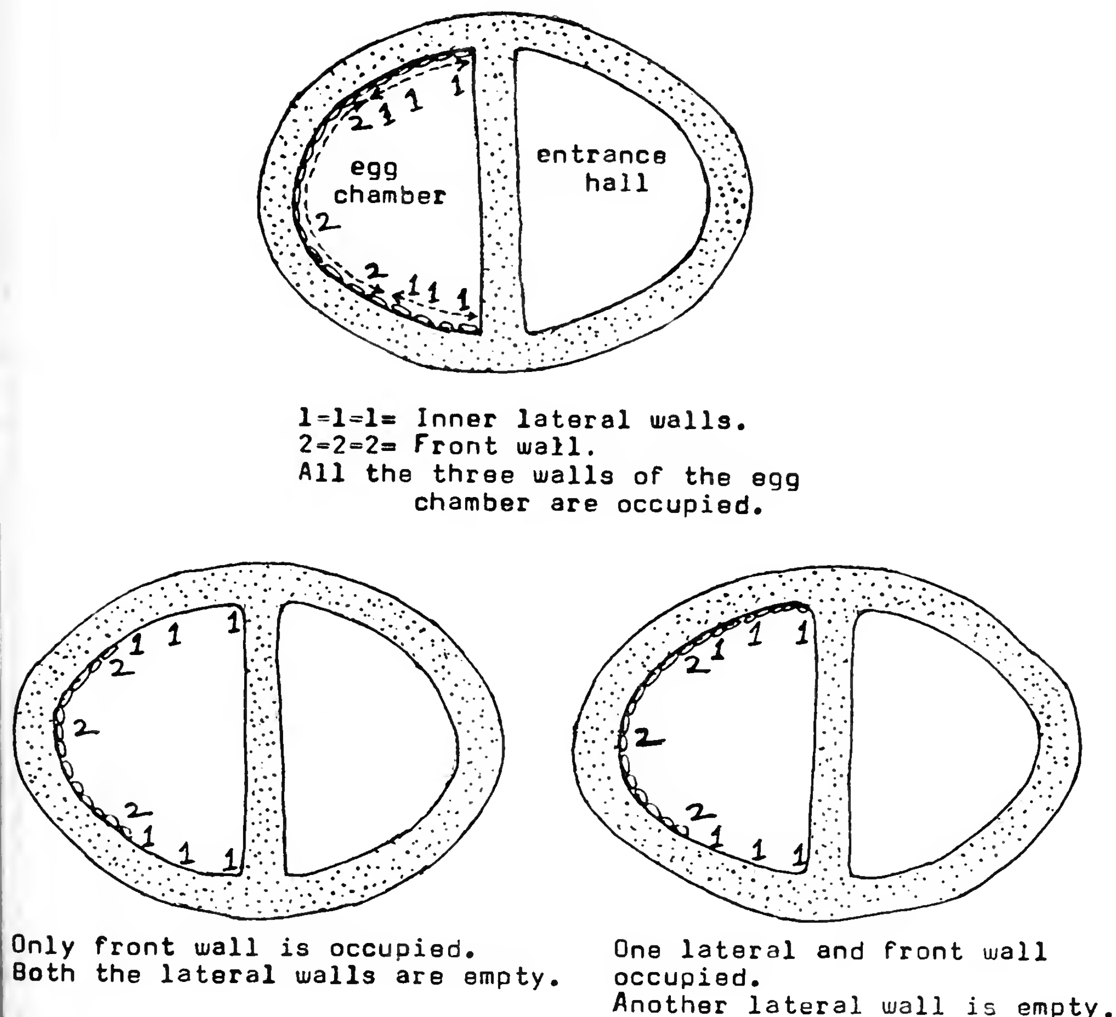


Fig. 2. T.S. of middle part of the nest of *P. benghalensis* showing few patterns of deposition on front & lateral walls of the egg chamber.

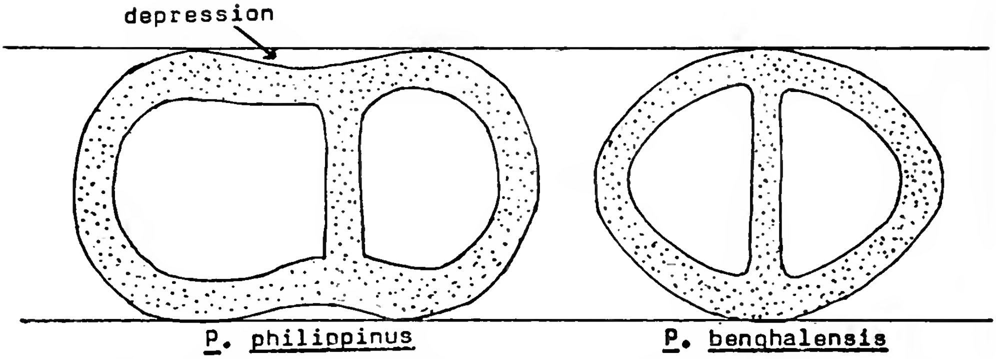


Fig. 3. Diagram showing outer shape of the nest in T.S. of both the species. T.S. are taken from the same topography of the nest of middle region.

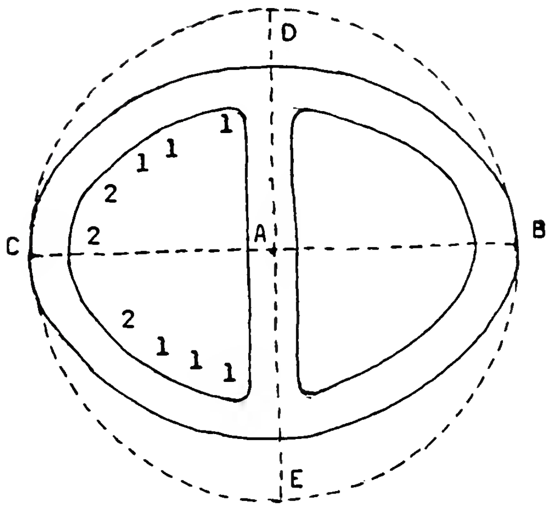


Fig. 4II. T.S. of the middle part of the nest of *P. benghalensis* showing geometry of the nest.

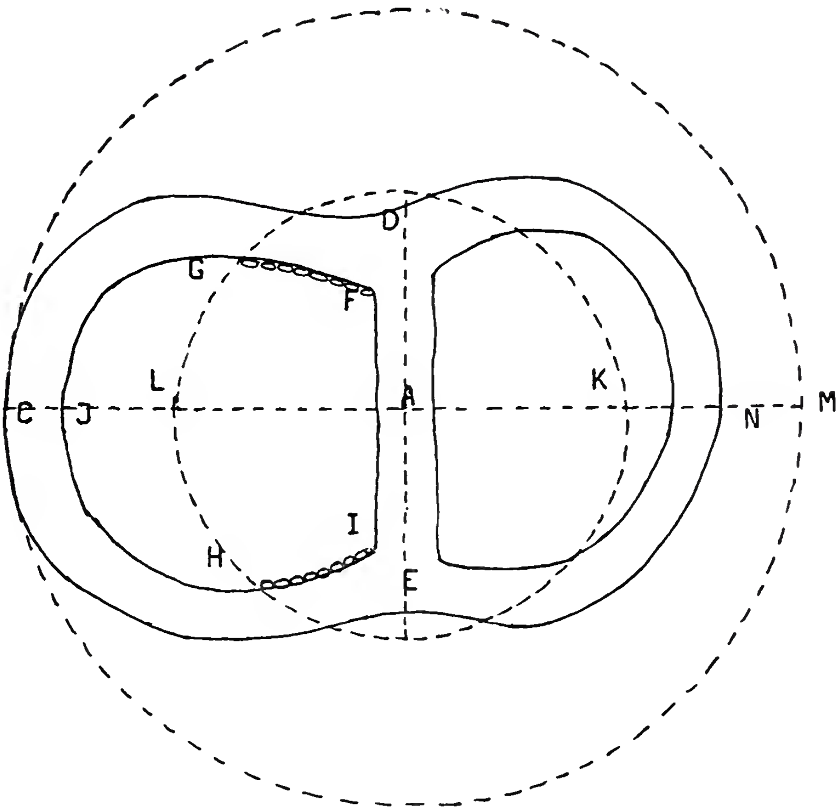
middle part of the nest of *P. benghalensis* occurs more or less equal while they remain unequal in nests of *P. philippinus*. Because two different radii in the nest of *P. philippinus* are unequal so we can call them by two different names — the short radius and the long radius with respect to their lengths. Such difference does not exist in case of *P. benghalensis* hence such nomenclature of the radii is not necessary in its case. (See fig. 4I & 4II).

The average length of the body of both the species is approximately 15.0 cm. Average half length of the body of *P. benghalensis* is larger than average radius (5.9 cm) of its own nest. When the nest builder male bird sits on the ring (a suitable nest weaving place) it is able to cover the whole inner wall of the egg chamber (Bird enters entrance hall, through entrance tube and sits on ring. In such condition the egg chamber always remains in front of its bill.).

The average half length of the body of *P. philippinus* is larger than the short radius (5.7 cm) but smaller than long radius (8.5 cm) of its own nest, taken from middle portion of the nest. In the nest of *P. philippinus* both the lateral walls of the egg chamber occurs at small radius, hence they remain within reach. The front wall of the egg chamber occurs at long radius, which is beyond the reach of the bird hence not used. In other words both the lateral walls of the egg chamber occur near the ring of the nest while the front wall

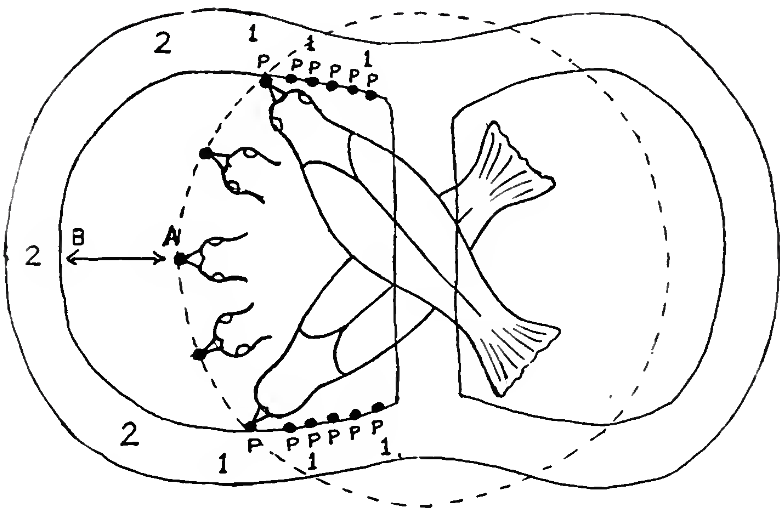
of the eggchamber remains at longer distance from the ring. When the bird rests on the ring both the lateral walls remain in the close vicinity of its bill while the front wall remains far from it. That is why both the inner lateral walls of the nest are plastered with wet mud by its bill but front wall remains free.

Nest of *P. benghalensis* possesses the ring more or less in its middle region which divides the nest cavity in two equal halves. But nests of *P. philippinus* possess the ring slightly shifted towards entrance hall which do not divide the nest cavity into two equal halves. Half of the egg chamber remains larger than another half of the entrance hall. In such condition two walls out of three of the egg chamber



(i) A = Centre of both the circles (Big × Small). "A" is situated on the ring DAE.
(ii) LA=AK=AD=AE—short radius (5.7 cm). (iii) CA=AM—long radius (8.5 cm).
(iv) CA ≑ AN, i.e. ring is slightly shifted towards entrance hall.
(v) GF and HI are parts of inner lateral wall of the egg chamber situated on small radius hence they are such parts where bird can deposit mud very easily.
(vi) GJH — Front wall of the egg chamber situated on long radius beyond the easy approach of bird's bill hence remains unoccupied.

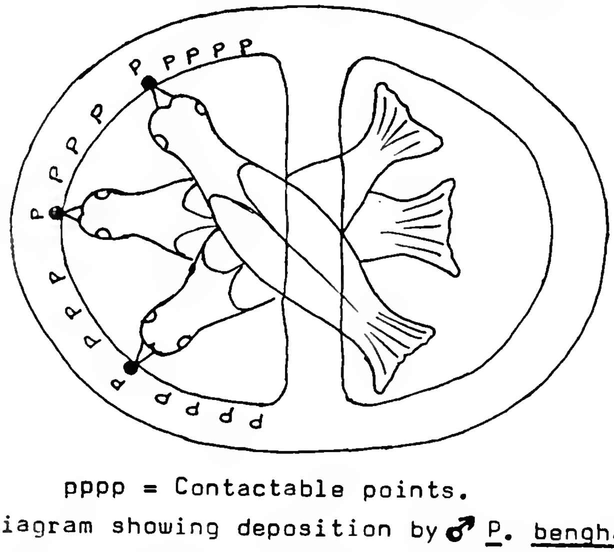
Fig. 4I. T.S. of the middle part of the nest of *P. philippinus* showing geometry of the nest.



pppp = easily contactable points of inner lateral walls of the egg chamber.

AB = Distance of front wall from easy approach of bird.

Diagram showing collection of mud in lateral walls of the egg chamber by ♂ P. philippinus.



pppp = Contactable points.

Diagram showing deposition by ♂ P. benghalensis.

Fig. 5. Easily contactable points in nest cavity of *P. philippinus* and *P. benghalensis*.

remain near to the ring and are used. The remaining front wall is not being used at a distance from the sitting place, i.e. the ring. In other words when male *P. benghalensis* sits on the ring of its own nest, it can touch every point of the three inner walls by its bill while it is difficult to *P. philippinus* which can touch two inner lateral walls only. That is why *P. benghalensis* can use all the three inner walls of the eggchamber of its nest while *P. philippinus* can plaster the two inner lateral walls only. (See fig. 5).

I am grateful to the Bombay Natural History Society for providing necessary guidance.

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18. A GHARIAL (*GAVIALIS GANGETICUS*) AT GAHIRMATHA COAST, ORISSA, INDIA

(*With a photograph and a text-figure*)

Referring to Annandale's (1915) statement about the occurrence of gharial (*Gavialis gangeticus*) in the Chilka lake, Singh (1978) held the opinion that since the local fishermen interviewed at Puri and Balugan were ignorant of the occurrence of gharial in this brackish water lake, gharial may be entering the lake accidentally during the monsoon floods through a tributary of the River Mahanadi. However, discussing the occurrence of gharial outside freshwater, Singh (1978) did state that inspite of the popular belief that the species remains away from estuaries, they are known to have occurred in the past in the "brackish waters near Kendrapada-Patamundai in lower Mahanadi, not far from the Bay of Bengal".

Supporting the above view regarding the possible occurrence of the gharial outside freshwaters, we have recorded a case in the Gahirmatha coast, Bhitarkanika Wildlife Sanctuary, Orissa, where a female gharial approx. 3 m in length was sighted on the sea shore. Observations recorded are presented below and the gharial with the sea in the background is seen on photo (1).

During a beach patrol for olive ridley's nesting emergences, a gharial was spotted basking on the beach on 30th January, 1985 at 1700 hrs. about one kilometre south-west of the village Kanpur (Fig. 1). On 31st January at 1600 hrs. it was again sighted at 1 km south-west of the Gahirmatha Marine Turtle Research and Conservation Centre located at 'Habalikhati'; thus the shift was about 7 km towards north in 12 hrs. On the same night when we tried unsuccessfully to capture the animal at 2000 hrs. it was sighted near 'Antamahalhana' at 1.8 km further north from 'Habalikhati'.

On 1st February, 1985 at 0845 hrs. the gharial was seen basking 2.4 km away from the previous recording. It moved about 100 m within 30 min. The last sighting of the gharial was at 1345 hrs. when it moved 2.5 km further north. No further observations were taken as we had to shift our camp.

Therefore, during 3 days the gharial had moved 13.7 km north of the first sighting.

Two of the movements were: 7 km in 25 hrs. (30.1.1985) and 2.5 km in 0430 hrs (1.2. 1985). These observations recorded on the coast augment the species' movement records in Satkoshia Gorge Sanctuary given by Bustard and Singh (1984).

The direction and flow of current in this part of the Bay of Bengal is from South to North (Bhanj Deo, Undated). Therefore, without much effort in swimming the gharial was just being taken away by the currents although the animal may be attempting to find a suitable place for basking on the beach and/or a freshwater habitat for retreating back. Everytime we approached close the gharial moved towards the open sea. However, throughout the 3 days observation period the gharial was observed swimming only within 50 m of the shore, raising its head frequently.

Singh and Bustard (1982a, b) stated that the gharial is extinct in the Brahmani and Baitarani systems to the delta of which Gahirmatha is close. Therefore, the present gharial is likely to have migrated from the Mahanadi where resident population still occur and where a rehabilitation programme is in operation (FAO 1975, Singh *et al.* 1984).

As regards the point of entrance into the sea it is difficult to guess but the two possibilities are: through the Mahanadi delta at Paradip (40 km south-west of Gahirmatha) or through the Brahmani-Baitarani systems. This migration may be purely accidental and perhaps had taken place or commenced during the high flood in September last, and this movement cannot be compared with the seasonal movement of the Asian giant turtle *Pelochelys bibroni* which leaves the freshwaters

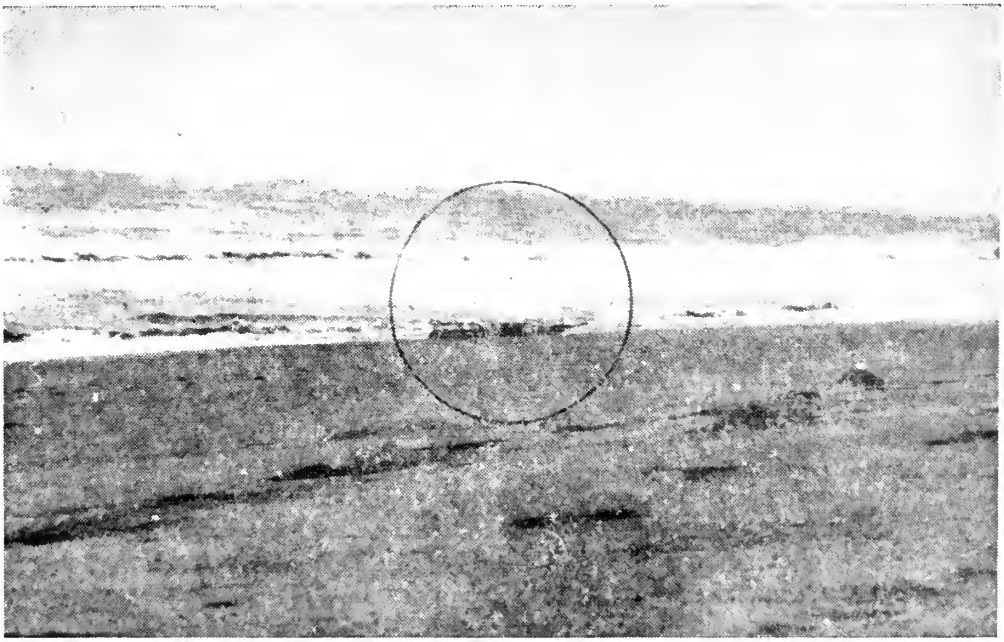

Photo. 1. Gharial on the coast.

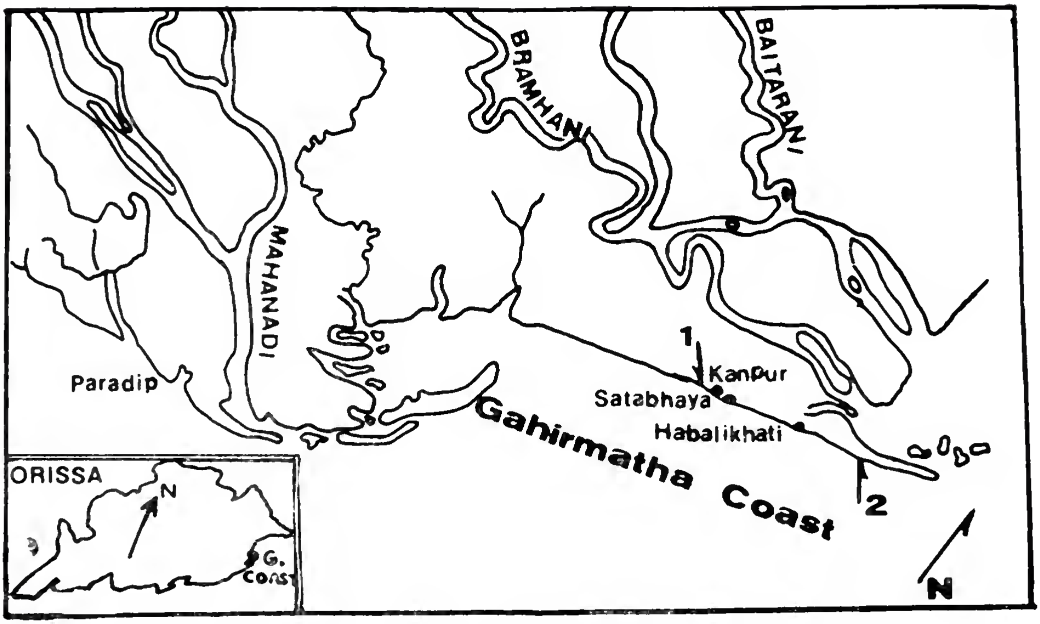

Fig. 1. Mouths of major rivers near Gahirmatha, Orissa where 3 m long female gharial was sighted on the coast. 1. First sighting (30.1.1985). 2. Last sighting (2.2.1985). 1-2 distance: 13.8 km.

of Brahmani and Baitarani and shares the same nesting beach with the olive ridley (*Lepidochelys olivacea*) and during which season it may occasionally enter the sea.

ACKNOWLEDGEMENTS

We thank the Forest Department, Govt. of Orissa for help and support on this survey of the coast-line and the Sambalpur University and Wildlife Institution of India, Govt. of India, respectively for facilities and to L. A. K. Singh for help in the preparation of the note.

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19. UNUSUAL EGG-LAYING IN A CAPTIVE SOFTSHELLED TURTLE *TRIONYX GANGETICUS* (CUVIER)

Turtles have a remarkable ability to survive under very circumscribed captive conditions but then their normal behaviour is altered. Excepting a few descriptions like of *Trionyx sinensis* (Mitsukuri 1895) where the turtles were maintained in semi-natural conditions, most other data on nesting in captivity are not reported because the behaviour is unnatural (Moll 1979). While conducting a study on the reproductive physiology of the freshwater turtle *Trionyx gangeticus*, a turtle weighing 7 kg and 46 cm carapace length was purchased from the local fish market during the last week of September, 1981 and brought to the laboratory where it was kept in a tank measuring 1.5 x 0.4 x 0.3 m. The turtle ate very little in the laboratory but remained active. In the tank it laid 7 eggs during the first week of October, 2 eggs on November 5 and 3 eggs on December 22, when on dissection three more eggs were found intact in the left oviduct. The right oviduct was empty. Each ovary also contained large vitellogenic follicles 19.3 ± 1.926 mm in diameter. Only 6 fresh corpora lutea were present in the ovaries but a number of atretic follicles were discernible by gross inspection, indicating that the 6 eggs found in December may be of a new clutch as the number corresponds with the corpora lutea found in the ovaries. All 15 eggs were well calcified, each with a weight of 15 g and diameter 29 mm.

A natural clutch of small *T. gangeticus* (mean carapace length 45 cm) have upto 15 eggs (Rao 1982, Singh, in press) and of large turtles with 60 cm (mean) carapace length have upto 40 eggs (Rao 1982). In the observations reported above, the clutches of 7 and 2 eggs found during October and November in a span of 4 weeks are believed to comprise a single natural clutch that had completely developed by the time the turtle was transferred to captivity. The eggs (3 nos.) laid on December 22 and those found in the oviduct (3

nos.) had developed in captivity as a single clutch as evident from the number of corpora lutea. Both the clutches, though developed normally, were split to smaller clutches for laying.

These observations confirm Moll's (pers. comm.) observations on the North American turtles that turtles kept under unnatural conditions may not lay normal clutches. This is believed to be a general phenomenon with most other reptiles. Therefore, for better success in captive breeding the rearing facilities should be as simulating as possible to the natural conditions.

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20. CONTRIBUTIONS TO THE BREEDING BIOLOGY OF THE SKINK (*LEIOLOPISMA HIMALAYANUM*), FROM KASHMIR

The breeding biology of the skink *Leiolopisma himalayanum* and of the family Scincidae in general is poorly known. This species is very common in the W. himalayas. Smith (1935) considered it to be viviparous, producing 3 or 4 young at a time. Annandale states that females examined in Kumaon in May contained eggs, but not those examined in September.

One of us (NJ) collected some reptiles from Overa, near Pahalgam, Kashmir in May-June 1985. While examining two specimens of *Leiolopisma himalayanum* in the society, they were found to contain eggs. Both the specimens were dissected on 21st July and 8 eggs each were taken out. One specimen (A) was collected on 8th May at 8500' and the other (B) on 25th June at 7500'. Both were collected in grass, in coniferous forest and were rather sluggish, as in the early morning cold and also possibly as they were gravid.

MEASUREMENTS:

Eggs of specimen (A):

8 eggs and 1 undeveloped. They were placed in two rows of 4 each. The eggs were yellow in colour and remarkably resembled corn grains but had a much more squarish appearance.

Measurements (in mm):
7.0 x 6.35; 6.60 x 6.45; 6.35 x 5.30; 6.95 x 5.50; 7.0 x 5.90; 6.50 x 5.20; 6.40 x 4.45; 6.75 x 5.90. Average size was 6.69 x 5.64.

Eggs of specimen (B):
Eggs were situated in the same position as 'A'. But they were larger in size and more elongated. The colour of the egg was pale cream, with very soft, 0.6 mm thick cover.
Measurements (in mm):
11.35 x 6.25; 11.50 x 6.55; 11.55 x 6.35; 11.10 x 6.65; 10.85 x 6.45; 11.30 x 6.85; 10.60 x 6.40; 9.65 x 5.90.
Average 10.98 x 6.42.

The difference in time between the collection of the two specimens was 48 days and the difference in the average sizes was 4.29 x 0.78.

An egg measuring 11.55 x 6.35 was opened and found to contain embryo in very early stage of development.

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21. TWO CASES OF "BACKWARD" SWALLOWING OF PREY BY THE RAT SNAKE (*PTYAS MUCOSUS*)

A rat snake being chased by some people, climbed onto my motorcycle and finding its way into the gearbox got its head stuck in the chain cover. The heated engine must have killed the snake as it was dead on removal.

It measured 1.59 m, and on dissection, the intestine contained a grey musk shrew, *Suncus murinus* 18.5 cm long and a young garden lizard, *Calotes versicolor* 15.5 cm long. The interesting part was that both the shrew and the lizard were arranged so that their heads pointed towards the mouth of the snake. Snakes usually swallow prey head first, so as to prevent ruffled scales, claws, spines, hair etc. preventing the smooth movement of the prey down the intestine. An additional example is Gay's (1978) record of a green keelback, *Macropisthodon plumbicolor* seizing frog deliberately by the head before beginning to swallow it.

In a reply to my letter Mr. Romulus Whitaker, herpetologist, writes, "In the United States, several species of watersnakes with long rear "frog teeth" swallow prey tail first. I assumed this was so because with a frog ballooned out in its defence stance, the snake would have to first puncture the abdomen to get it down to a respectable size. In fact all the nactricines do this. In India, I have come across a few cases of "backwards" swallowing. It may be a matter of personal idiosyncracy. I have seen large rat snakes swallow rats sideways and pythons to the same with chickens".

Flying snake *Chrysopelea ornata* (Shaw).

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22. A NOTE ON REPRODUCTION IN THE FLYING SNAKE *CHRYSOPELEA ORNATA* (SHAW)

(*With a plate*)

A 1.25 m., long-time captive flying snake (*Chrysopelea ornata*) at the Madras Snake Park Trust (MSPT) laid eggs three months after an adult male of the same species was introduced into her enclosure. Since very little information is available on the breeding habits of this species a detailed account of this breeding instance is presented in this note.

Background:

The following information on the reproductive habits of the flying snake was gleaned from a review of available herpetological literature:

1. Pairing (in Bangkok) takes place in June and from 6 to 12 very elongate eggs are laid at a time according to Smith (1943).
2. Eggs (in West Bengal) are laid in February and March according to Whitaker (1978).
3. Daniel (1983) and Whitaker (1978) give the length of new-born young as 114 to 152 mm and 200 mm respectively.

DETAILS OF THE BREEDING AT MSPT:

Eggs: 17 eggs forming a compact agglutinated mass were laid on the floor of the female's enclosure on 17 May, 1984. The white eggs were variable in shape as can be seen from the measurements given in Table 1, and none could be described as being "very elongate".

TABLE 1

MEASUREMENTS OF THE 4 FERTILE EGGS AND RESULTANT HATCHLINGS OF *C. ornata* (IN MM.)

Egg			Hatchlings	
No.	L	D	snout to vent	tail
1.	27	16	210	80
2.	23	16	200	70
3.	29	17	220	80
4.	31	16	220	81

L = Length; D = Diameter

Incubation: The following method of artificial incubation — one which has proved very successful with snake and lizard eggs — was adopted:

The egg mass was removed from the enclosure and transferred to a polythene bag with a substrate of moist cotton-wool. The bag was

inflated full by mouth and closed tightly with rubber bands. It was then placed in a wooden box having wire mesh at opposite ends and which was situated 1 m. away from a desert air-cooler. A near constant temperature of 29°C and relative humidity of around 90% could be achieved through this arrangement. The eggs were visually inspected every day and whenever any of them dented, water was added to the cotton-wool substrate. Dented eggs, especially fertile ones, usually regained their turgidity within 24 hours of addition of moisture. The polythene bag was inflated whenever necessary and the substrate was changed if growth of mold was noticed.

Hatching: 13 eggs (76.5%) out of the total of 17 proved to be infertile. The four fertile ones hatched on 1st August, 1984 after an incubation period of 76 days. The neonates, which were all females, were very alert and active. They exhibited identical body colours and patterns, a description of which is given below:

Dorsal body colour black with 69 to 72 narrow bright yellow cross-bars, each with a central crimson spot. Colours of head distinctly divided horizontally. Top of head with thin transverse yellow bars. Upper lip edged with black till the 4th supra-labial. Ventero-lateral areas in the neck region pale yellow. Ventrals pale green, turning black posteriorly. Under side of tail black with a median pale yellow line running its entire length.

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23. COMMENT ON CANNIBALISTIC PROPENSITIES IN HIMALAYAN NEWTS

While studying the ecology and behaviour of Himalayan newts (*Tylototriton verrucosus*) in rock pools of eastern Nepal, I collected 10 live specimens of newt larvae from highland rock pools of Chulachuli village (altitude 6000 ft.). They were miniatures of the adult newt having well formed four limbs, lateral tubercles and fully absorbed gills. I photographed the newt larvae individually and as a group found them to be perfectly healthy and alert. All 10 larvae were kept in an earthen pot and carried downhill and included a 10 hour walk to the bus station for the night journey. The water was changed in the earthen pot but some larvae were motionless and some were gasping.

They were therefore transferred to a polythene container and flushed with fresh water. I accidentally detected two of the larvae had already lost hind limbs, and were bleeding. When the larvae arrived in Kathmandu the next morning I again found that another two

larvae had each one fore limb missing. I placed the remaining 6 larvae with intact limbs in a small aquarium of about 2000 cc capacity. For experimental purpose, I kept the newts fasting and observed the activity of the young newts for seven days. On the 3rd and 5th day I witnessed two dominant larvae cornering the smaller larvae and gradually biting their hind limbs. During the attack the vietims struggled to eseape. Having been convinced fully of existence of cannibalism, I removed the injured newt from the aquarium and reared them individually in separate containers.

The wounds healed after two weeks and limbs started growing. After four months the limbs were completely regenerated. All captive larvae were fed with fish meat. Partieularly, the pulpy flesh of a cyprinid fish locally known as Sidhra (*Puntius ticto*) was found to be a good nourishing food for larval newts.

To study cannibalism among adults I eollected 20 newts from their natural habitat in the eastern Nepal. Among these 15 refused food in captivity and died in the span of a month. The remaining five were foree fed and survived. In the first week of February, forty newts from the same habitat were collected and reared in 5 aquaria. Ten wild newts were kept in No. 1. Five surviving newt from earlier collection in No. 2 and five newts from the recently collected stoek in No. 3. Five juvenile newt with fully absorbed gills and five wild newts were kept in No. 4 and in No. 5 only juvenile newts. All the newts were fed with fish. I did not observe eannibalistic propensities in aquarium No. 1 to 4 but in aquarium No. 5, I again notieed three newts losing limbs. Biting and snapping happened only when they were disturbed by using sticks. The adult newts were docile and tolerated the presense of young newts in the same aquarium. No injuries were detected. Young newts often rested on the baek and head of the adult newt. I also took samples of newts from different roek pools, and eould not deteet injured or lame specimen or specimen with regenerating limb. The sampling result provided me indireet evidenee that cannibalism does not take place in nature.

Cannibalism is thus not an inborn eharaeter of newts. It takes plaee only in gilled stage. This hypothesis is supported by my studies in nature and eaptivity. As reported by Gyi (1971) I also believe that most probably cannibalism does not take place among adult newt in the natural habitat as there is abundanee of food and shelter.

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24. ABERRANT COLOUR PATTERN IN THE STRIPED LOACH, *BOTIA STRIATA* RAO (PISCES: COBITIDAE)

(*With a plate*)

Normal coloration in the adult striped loach, *Botia striata* Rao, consists of a series of narrow, obliquely vertical stripes along the body. Although, on casual observation these appear to be uniformly distributed, a closer look reveals that the width of the light coloured stripes between the dark stripe is not uniform. In between two broad light stripes are three narrow light stripe. While the central stripe of these three is straight, the two light stripes on each side of this straight stripe are sinuous.

Each composite group of such five stripes is the result of splitting occurring with the growth of the fish. Juveniles have five broad, wedge-shaped bands along the body, each split into two by a narrow white stripe. As the fish grows, each half of these dark wedges splits, finally giving rise to the adult colour pattern. This normal colour pattern of juvenile and adult has been illustrated in our earlier paper (1980).

During the course of examination of thousands of *Botia striata*, we have, several times, come across specimens exhibiting aberrant colour patterns. These usually manifest themselves in the form of contorted loops and spirals, somewhat akin to those found on finger prints.

The cause of such aberrant colour patterns can only be surmised. Since such patterns are not symmetrical on both sides of the body, it is felt that the pattern is a result of injury to the fish, involving loss of some of the minute scales at the site of injury. Formation of new scales and their arrangement in a haphazard pattern might then result in the contorted whorls.

Incidentally, the fish described by Babu Rao & Yazdani (1977) as *Botia dayi* Hora is actually *Botia striata*, it being a case of wrong identification. This can be seen in their photograph, which shows the normal colour pattern. Nor is their claim that theirs is the first record of any *Botia* from the Western Ghats correct, since they have ignored earlier records of this genus by Kulkarni (1951) and by Kalawar & Kelkar (1956).

The accompanying illustrations are based on actual photographs of preserved specimens. The specimens are deposited in the collections of the Zoological Survey of India.

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SACHETAN,
L/4-5, SITARAM BUILDING,
PALTON ROAD,
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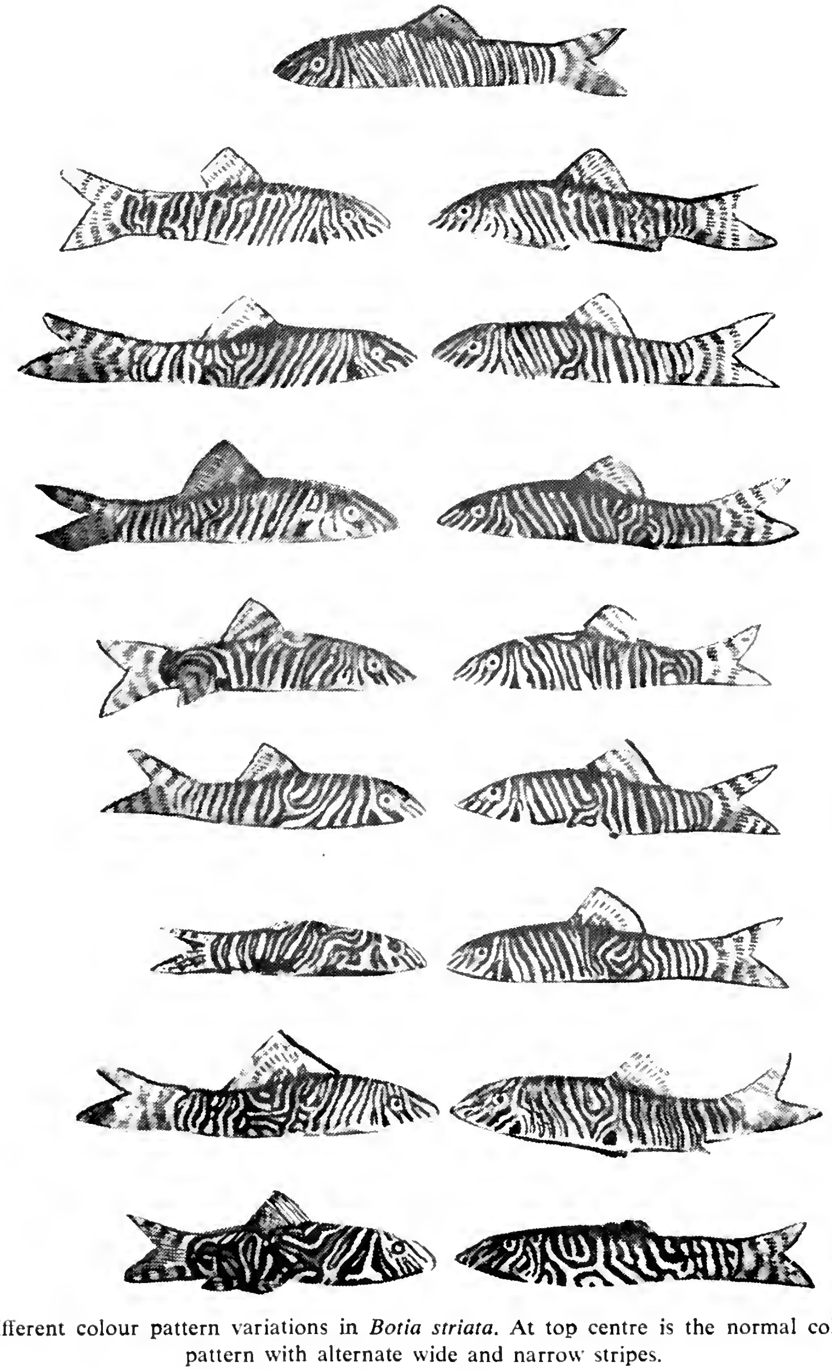
June 18, 1985.



Different colour pattern variations in *Botia striata*. At top centre is the normal colour pattern with alternate wide and narrow stripes.

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25. NEW ADDITION TO THE LIST OF HOST PLANTS OF THE CITRUS BUTTERFLY, *PAPILIO DEMOLEUS* (PAPILIONIDAE: LEPIDOPTERA)

The citrus butterfly, *Papilio demoleus* has been reported to be a pest of *Acronychia laurifolia, Feronia elephantum, Glycosmis pentaphylla, Murraya roenigii, Psoralia corylifolia, Ruta angustifolia, R. graveolens, Triphasia trifoliata, Zizyphus jujuba,* lemon and orange trees (Beeson 1961). Vasanthraj David and Kumarswami (1978) have also reported this insect on *Aegle marmelos* and *Psoralea corylifolia.*

In October 1984, the insect was found feeding on sampige, *Michelia champaca* and custard apple, *Anona squamosa* that were grown in the garden of the co-author at Banshankarinagar, Dharwad, Karnataka. All the three stages i.e., egg, larva and chrysalis were found on the plants. Greyish yellow eggs were laid on the tender leaves and larvae were found feeding on the foliage of the plant. The chrysalis fastened to the plant by a gridle of fine silken threads.

The larvae were also found to feed under laboratory conditions on the leaves of sampige and custard apple. The pest was controlled by use of 36 ml of Endosulfan, 35 EC, in 18 litres of water.

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26. FIRST RECORD OF TWO HYPERPARASITES OF *LIPAPHIS ERYSIMI* (KALT.) (HOMOPTERA- APHIDIDAE) PARASITIZING *APHIDIUS RAPAE* (CURTIS) (HYMENOPTERA — APHIDIINAE)

Hyperparasites are occasionally mentioned as factors of possible importance in influencing the number of the primary parasite, *Aphidius rapae* (Hafez 1961). According to Doutt and Debach (1964) care must be taken to prevent the introduction of hyperparasites in the fields and is based on the notion that the hyperparasites may seriously affect the efficacy of

primary parasites. Yet, the reported hyperparasites parasitizing the *Aphidius rapae* (Curtis) are — *Asaphes* sp., *Charips* sp., *Lygocerus* sp. (Sedlag 1958); *Asaphes vulgaris* Wlk., *Charips minuta* Htg., *Pachyneuron aphidis* Bcl. (Belanov'skii 1938); *Asaphes vulgaris, Charips ancylocera* Cam., *Lygocerus aphidivorous* K., *Pachyneuron minutissimum* Fo. (Hafez 1961); *Charips* spp. (Ullyett 1938) and *Asaphes* sp., *Charips* spp. (Barnes 1931). During rearing of *Aphidius rapae*, a parasite of mustard aphid, *Lipaphis erysimi*, two new hyperparasites were noticed which have been determined as *Opius* sp. (Braconidae — Hymenoptera) and *Dendrocerus* sp. (Megaspilidae — Hymenoptera). Both the hyperparasites, have not yet been reported parasitizing any aphid parasite and present report on the aphid parasite *A. rapae* is a new record. Percentage of hyperparasitization has also been studied and it was found that for *Opius* sp. the percentage varied from 3 to 15 and for *Dendrocerus* sp. from 5 to 20. Thus, these two hyperparasites may contribute to reducing the efficiency of the primary parasite *A. rapae.*

Both the species of hyperparasites were determined by G. E. J. Nixon of the Commonwealth Institute of Entomology, London. We are extremely obliged to him.

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27. OCCURRENCE OF *CELOSTERNA SCABRATOR* VAR. *SPINATOR* ON EUCALYPTUS

(*With a photograph*)

During January 1985, I noticed that nearly every eucalyptus plantation of 1983-84 in Gulbarga division was attacked by the cerambycid borer, *Celosterna scabrator* var. *spinator*. Eucalyptus seedlings 2-3 year old were attacked to the extent of 20% and small heap of frass could be noticed at the base of the attacked seedlings.

I had observed the same species attacking *Acacia nilotica* in Gulbarga during Dec. 1983.

Beeson (1961) reported *Celosterna scabrator* as attacking *Acacia arabica, A. catechu, Cassia siamea, Casurina equisetifolia, Pithecolobium dulce, Prosopis juliflora, P. spicigera, Tectona grandis* and *Zizyphus jujuba* and has also given details of its life-history and damage.

Photo. 1. Adult *Celosterna scabrator* var. *spinator* feeding on Eucalyptus bark.

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REFERENCE

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28. SCIENTIFIC VERSUS POPULAR NAMES

Dr. R. K. Varshney, the Deputy Director of the Zoological Survey of India, has very kindly sent me a copy of his paper "Common names of the butterflies from India and neighbouring countries". In the first place, I must congratulate him on a most meticulous and careful piece of work.

On second thoughts, however, I cannot help feeling certain reservations on whether the list is really necessary. Generally speaking, English in India is a second language and I question whether learning such a list of names

in a foreign language is really much less difficult than learning a list of scientific names, despite many advocates of such common names; I cannot help feeling that it is better to take one bite at the cherry instead of two. It is, I think, essential that English common names, whether used in India, Britain, the U.S.A. or anywhere else should be the same. No amount of logic is going to make the British use 'Admirable' for 'Admiral' for *Vanessa atalanta*, and *Vanessa indica* is the 'Indian Red Admiral' in the Canary Islands and Madiera (1) and *Vanessa itea* is the 'Australian Admiral'; again take *Nymphalis antiopa* — the British call it 'Camberwell Beauty', now part of Greater London, the Americans 'Mourning Cloak' and Dr. Varshney in his list calls it 'Camberwell Beauty Tortoiseshell'. Dr. Varshney calls *Nymphalis polychloros* and *Aglais urticae* the 'Blackleg' and 'Mountain Tortoiseshell' respectively, in Britain they are the 'Large' and 'Small' Tortoiseshell, and *Nymphalis xanthomelas* is the 'Yellow-Legged Tortoiseshell' of Eastern Europe (1), a direct translation of the classical name. Dr. Varshney calls it the 'Large' Tortoiseshell in his list. Would it not have been better to have left these species with their original names ? Again 'Eggfly' seems a meaningless name for the two Indian species of *Hypolimnas*, and even more so when applied to some of the African species of the genus. I can cite other examples of a similar nature.

In conclusion, I query the real value of Dr. Varshney's list. Very few Butterflies are of economic importance, and a similar list of common names for Moths of economic importance could probably be of much greater use. Furthermore it is unfortunate that Dr. Varshney's list has added considerably to the confusion in the synonymy of the English Common Names of the butterflies occurring in both India and Europe.

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29. DESCRIPTION OF AN UNKNOWN FEMALE OF *PSEUDOSTENHELIA SECUNDA* WELLS, 1971 (COPEPODA-HARPACTICOIDA)

(*With twelve text-figures*)

Wells (1967) established the genus *Pseudostenhelia* for a new species of harpacticoid copepod, *Pseudostenhelia prima* in the family Diosaccidae. He remarked on its close resemblances to the genera *Stenhelia* Boeck, 1864 and *Melima* Por, 1964 in body shape, mouth parts and P.5 female. The absence of an elongated seta on the endopod of the mandible, the two segmented endopod of P.2-P.4 and the male characters in P.2-P.3 were considered as distinguishing characters of the genus *Pseudostenhelia*. Later two more species namely *P. secunda* Wells, 1971 and *P. wellsi* Coull and Fleeger, 1977 were added to this genus. Males and females are known in *P. prima* and *P. wellsi*. Wells (1971) erected his

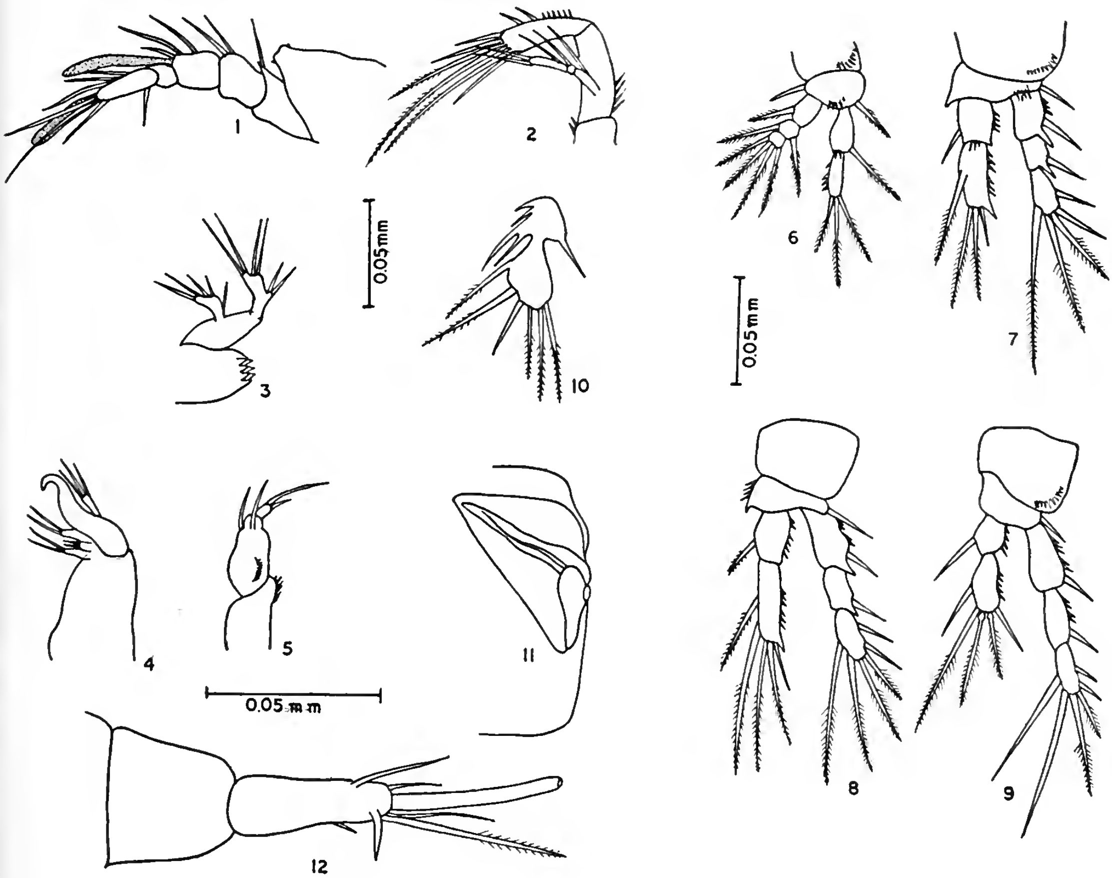
new species *P. secunda* based on male specimens collected from fine sediments of Vellar estuary, east coast of India, and females were not then known. During the survey of the meiofauna in the Gautami Godavari estuarine system, numerous male and female specimens of *P. secunda* were collected in the intertidal muds of a mangrove biotope.

DESCRIPTION: Based on a ovigerous female (650 μm).

Body broad, metasome and urosome well demarcated. Cephalothorax rounded anteriorly. Rostrum broadly triangular with a trifid apex with a sensory seta on each side. Genital apparatus in two unconnected lateral parts (Fig. 11). Caudal rami about twice as long as broad. Terminally a well developed seta flanked by two very weak setae. Inner and outer edges with a seta distally (Fig. 12). All ovigerous females with 2 egg sacs, each egg sac with 4-6 eggs.

Antennule (Fig. 1): Five segmented. An aesthete on segments three and five.

Antenna (Fig. 2): With allobasis. Exopod



Figs. 1-12. *Pseudostenhelia secunda*: 1. Antennule; 2. Antenna; 3. Mandible; 4. Maxilla; 5. Maxilliped; 6. P.1; 7. P.2; 8. P.3; 9. P.4; 10. P.5; 11. Genitalia; 12. Caudal ramus.

three segmented, the first and third elongate, longer than the second. First two segments each with one seta, the third segment with one seta near the base of the inner edge and two terminal setae.

Mandible (Fig. 3): Pre-coxa well developed, cutting edge complex. Coxa-basis elongate. Exopod with five setae.

Maxillule: With massive basis. Exopod and endopod confluent at the base, with two and four setae respectively.

Maxilla (Fig. 4): Syncoxa with three endites. Basis with a massive terminal claw. Endopod one segment with three setae.

Maxilliped (Fig. 5): Not truly prehensile. Endopod, first two distal setae, second with a claw.

P. 1 (Fig. 6): Exopod three segmented, the last two very short, broader than long. Exopod shorter than endopod. First segment with an outer seta, second with an inner and an outer seta, third with one inner, two terminal and one outer seta. Endopod two segmented, not prehensile; first segment longer and broader than the second. First segment with an inner seta, second with three terminal setae.

P.2-P.4: Exopod three segmented, endopod two segmented.

P. 2 (Fig. 7): Basis with one outer seta and a spiniform inner distal corner. First endopod segment shorter than the second. Outer distal corner of second segment spiniform. Second segment with one inner and three terminal setae. The outermost terminal seta short and spiniform.

P. 3 (Fig. 8): Basis with one outer seta and a spiniform distal corner. Exopod segments longer than broad, the first segment longer than the second and third, which are equal in length. Third segment, two inner setae long and equal in size. First endopod segment shorter than the second. Inner distal corner of second segment neither rounded nor with spinulose edge (spinulose and rounded edge in male).

P. 4 (Fig. 9): Basis with an outer seta. Exopod, third segment with two inner, two terminal, and two outer setae. First endopod segment shorter than the second. Endopod not reaching halfway along the second exopod segment.

P..5 (Fig. 10): With rami indistinct. Inner expansion of basendopod not well developed. Basendopod with four setae. Exopod with six setae.

Locality: Intertidal mudflats of Gautami Godavari estuarine system.

Setal formulae of P. 1-P. 5 appendages of *Pseudostenhelia secunda* are given in Table 1.

REMARKS: The females of *Pseudostenhelia secunda* differ from the males in the structure of antennule, setation of second endopod segment of P.2 (female 4, male 3), in the modification of inner distal corner of second endo-

TABLE 1

SETAL FORMULAE OF *Pseudostenhelia secunda* WELLS, 1971

	P. 1		P. 2		P. 3		P. 4		P. 5	
Sex	Exopod	Endopod	Exopod	Endopod	Exopod	Endopod	Exopod	Endopod	Basendopod	Exopod
Male	0.1.121	1.111	0.0.122	1.120	0.0.222	1.221	0.0.122	1.221	Fused 3	
Female	0.1.121	1.111	0.0.122	1.121	0.0.222	1.221	0.0.222	1.221	4	6

pod of P.3 (males rounded with a spinulose edge, females not modified), in the number of setae of P.4 exopod (female 6, male 5). P.5 setae (female 4 and 6, male fused 3) and in the number of well developed setae on caudal ramus (female 1, male 2). Most of the above mentioned differences, except the modification of the inner distal corner of second segment of endopod P.3 and P.4 exopod setation (Table 1), are observed between males and females of *P. prima* and *P. wellsi.*

The female of *Pseudostenhelia secunda* closely resembles that of *P. prima* in the structure of antennule, antenna, mandible, maxilla, maxilliped and P.1. It also shows some resemblances with the female of *P. wellsi* in the number of setae on P.5 (4 and 6) and general shape of the caudal ramus. It may be mentioned here that the caudal ramus of *P. secunda* shows resemblance in shape with *P. wellsi*, but in the presence of a single well-developed terminal seta, it resembles *P. prima.* However, the female of *P. secunda* differs from the females of the other two species, *P. prima* and *P. wellsi,* in certain structural and setation differences exhibited in P.2-P.5. Conspicuously, *P. secunda* differs from the other two species by having a seta on the inner edge of the first segment of endopod of P.2 (absent in *P. prima* and *P. wellsi*), absence of a seta on the inner edge of second segment of exopod of P.3 (present in the other two species), and in the number of setae on the third exopod segment of P.2 and P.4.

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I thank Prof. S. Dutt, Head of the Department of Marine Living Resources, for his keen interest and constant encouragement in the present investigation; Dr. K. V. Ramana Murty for critically going through the manuscript and making valuable suggestions; and Dr. (Mrs.) A. Shameem for inking the diagrams and to UGC for providing a Junior Research Fellowship for carrying out this work.

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30. ON THE OCCURRENCE OF THE AMPHIPOD — *GAMMARUS PULEX* (LINN.) IN KASHMIR VALLEY, WITH REMARKS ON THE ECOLOGY OF THE SPECIES

In Kashmir Valley the amphipod — *Gammarus pulex* (Linn.) is very abundant, occurring in all types of habitats, and forms an important item of the food of fishes, especially the Trout, the Mahseer and the Mountain Barbel [*Oreinus plagiostomus* (Heckel)]. It

abounds in the streams and rivulets in the Valley and also in the Wular Lake, living under stones in loose and thick moss, but is absent from streams with "cemented" bottoms. The moss and dead leaves provide the crustacean with food as well as shelter. Huet (1942) is of the opinion that the greater abundance of *Gammarus* in small streams than in rivers is due to the reason that the larger volume of water in rivers tends to sweep these little animals away. Macan and Mackereth (1957) were, however, of the opinion that if the bottom was stable, the speed and volume of water flowing over it could not affect the organisms living underneath. They suggested that it might be predation that kept the numbers of *Gammarus* low in rivers.

Macan and Mackereth (loc. cit.) found that *G. pulex* was fairly evenly distributed along the length of a small stony stream and that its numbers did not alter much from month to month and from year to year. It is one of the first animals to reappear in a stretch of stream that has been dry and tries to swim against the current when exposed by the lifting of a stone sheltering them. They suggest that *Gammarus* tends to work its way upstream at all times but, when population becomes dense, there is mutual disturbance to such an extent that many may be pushed out from under the shelter of a stone and washed downstream again.

ACKNOWLEDGEMENT

I thank Dr. Roger J. Lincoln of the Department of Zoology, Section of Crustacea, British Museum of Natural History, London, for confirming the identification of the specimens under report.

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31. INVASION OF PURULIA, AN ARID DISTRICT OF WESTERN WEST BENGAL, INDIA, BY *ACHATINA FULICA*

The agrihorticultural pest *Achatina fulica*, introduced in Calcutta, India in 1847 is well established in the subcontinent, thriving in the hilly tracts of Eastern India, in the plains and in the coastal regions of India (Raut and Ghose 1984). In most of the areas of its distribution it is a serious pest.

In the survey on the distribution of *A. fulica* in India in 1975 Purulia was recorded as one of the districts in West Bengal free from the giant land snail (Raut 1979). During a recent study on the distribution and ecology of arid zone molluscs in August-September, 1984 *A. fulica* was found in a centrally situated area,

the Subhas Park in Purulia town. The population is yet to reach a high level but it is causing considerable damage to ornamental and flowering plants of the park. The park management is facing difficulty in proper maintenance of the garden.

Apart from many live snails of different size groups, quite a good number of empty shells, 98.3 mm and near equal sizes were recorded. To attain this shell size in West Bengal, India at least 4-5 yrs time is required (Raut and Ghose 1984) and the presence of a number of empty shells of this size indicates that *Achatina* must have reached there latest by 1978 and the individuals presently in the park were born in the following years. The findings lend support to the observations of Raut (1979) and Raut and Ghose (1984) that *A. fulica* will find a new home in Purulia, if ever introduced there. It is a timely warning to the administration that if proper measures are not taken immediately, the pest will spread to susceptible areas of the district and will make the farmers, already the poorest in West Bengal more poor.

We are grateful to Professor K. C. Ghose (Retd.), Department of Zoology, University of Calcutta for kindly going through the manuscript and offering valuable advice.

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REFERENCES

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RAUT, S. K. & GHOSE, K. C. (1984): Pestiferous land snails of India. *Technical Monograph*, No. *11*: 1-151 (with 17 plates).

32. THE FIRST REPORT OF THE ORDER SCHIZOMIDA (ARACHNIDA) FROM SOUTHERN INDIA

Schizomids are small arachnids that are generally found in forest litter, under stones, logs and in crevices. Due to their small size and secretive habits they go unnoticed and thus remain undiscovered is many parts of the world. So far 14 species (in two genera) have been described from India, Burma and Sri Lanka (Thorell 1889, Gravely 1912, Fernando 1957, Remy 1961). Of these, only three have been described from India: (1) *Schizomus lunatus* Gravely, 1911 (Calcutta, West Bengal, E. India), (2) *Schizomus kharagpurensis* Gravely, 1912 (Kharagpur, West Bengal) and (3) *Schizomus sijuensis* Gravely, 1925 (Siju Cave, Assam, NE India). In addition to these, Gravely (1912) reports the discovery of two new species of *Schizomus* from Chota Nagpur Division, Bihar Province of NE India. *Schizomids* were unknown from Southern India until

the present collections from Maharashtra State.

Three mature males and three mature females of an undescribed species of schizomid were collected (during July-August) from Sinhagad Fort, 30 km. SW of Pune, Maharashtra. This fort is situated at an altitude of about 1300 MSL in Western Ghats. The specimens were collected during the rainy season from under stones on top of the fort. The specimens are dark greenish-brown in colour and are about 4 to 5 mm in total length. This species is the third species of schizomid with eyes; the other two species being from Sumatra and Kew Botanical Gardens, London, England (Sissom 1980). The latter species is most certainly introduced to the Gardens, but its place of origin is unknown. The Indian species, like *Schizomus biocellatus* Sissom from Sumatra, has males which have dimorphic palps.

During my recent field survey of the eastern part of Sangli district, Maharashtra State, in September 1984, a single mature female schizomid was collected from wet leaf litter of the Myrtle (Jamun) *Sizygium cumini* (Linn.) Skeels. This specimen was collected at Bhiv Ghat, 40 km. SW of Atpadi, on Atpadi-Kharsundi Road, Taluka Atpadi at an altitude of about 760 MSL. The Bhiv Ghat specimen is about 4.25 mm in total length and light greenish in colour. Its proper assignment will have to await the study of the genitalia and comparison with specimens collected from Sinhagad fort or the capture of males.

The collection of six adults from Sinhagad Fort, Pune, and a female from Bhiv Ghat, Sangli are the first records of the arachnid order Schizomida, family Schizomidae, from Southern India. These records extend the known range as the nearest other localities of occurrence are in northern and northeastern India and Sri Lanka.

ACKNOWLEDGEMENTS

I sincerely thank Mr. J. R. Redell (Austin, Texas, U.S.A.) and Mr. J. C. Cokendolpher (Lubbock, Texas) who examined my schizomids and commented on the manuscript for its improvement. I am also thankful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta and Officer-in-Charge, Zoological Survey of India, Western Regional Station, Pune for providing necessary facilities to carry out this work and Dr. R. M. Sharma for his keen interest and help during the studies.

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33. FAMILY HIPPURIDACEAE IN THE KASHMIR HIMALAYAS

(*With a text-figure*)

A unigeneric family with wide geographical distribution. The family shows extreme floral reduction, the perianth being reduced to a vestigial rim round the apex of ovary. The androecium is reduced to a single stamen and there is a single pendulous ovule in unilocular ovary.

Hippuris L. Sp. Pl. 4 (1753).

Erect or decumbent, simple or branched herb. Leaves in whorls, simple; the aerial stems have relatively longer internodes and whorls of shorter rigid leaves. Flowers small, axillary; stamens single, inserted on the anterior edge of the calyx. Fruit one celled one seeded drupe.

Hippuris vulgaris L. Sp. Pl. 4 (1753); Clarke, Fl. Brit. Ind. 2; 432 (1878); Fassett. Man. Aq. Pl. 263 (1940).

The species can be easily identified in the field in its marshy or aquatic habitat in having the aerial portion densely covered with green leaves. Rhizomes creeping; roots arising from the submerged nodes. Leaves heterophillous; submerged ones in the whorls of 7-9 on a node, linear, acute, entire; aerial leaves 9-12 in a whorl. Flowers axillary, naked; perianth absent; anther bilobed, each lobe with a central raphe on one side; style filiform, bearing receptive papillae along the whole of one side. Fruit one seeded, globular, 1 x 1.2 mm, with an apical, short, blunt reddish beak. Pollen grains 4-6 colpoidate, prolate spheroidal-suboblate. 22.0 x 30.0 μ; furrows poorly defined; exine thin; meshes of the reticulum faint, nexine thicker at the angles. Polar field index 1: 5.1; Polar field-small.

The species is dominant in the Hokhar Sar lake and Anchar lake, also in shallow waters,

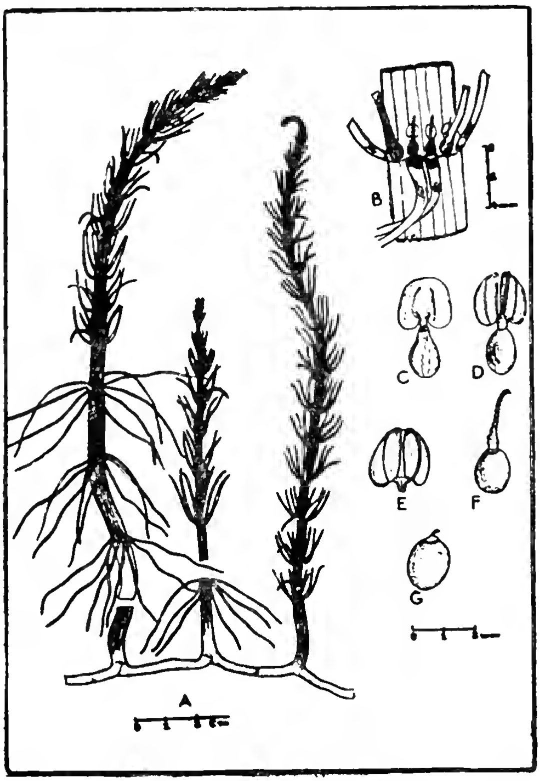

Fig. 1. *Hippuris vulgaris* L.
A. Habit; B. Node showing the arrangement of flowers; C.&D. flowers; E. Stamen; F. Ovary; G. Mature seed.

ponds streams, marshes. Sometimes near wet soils. Anchar lake A. M. KAK 3561; Highgam Rakh, A. M. KAK 3589; Hokhar Sar lake, A. M. KAK 3633.

Distribution: Europe, W & N Africa, Kashmir.

McCully and Dale (1961), after an intensive study of morphological plasticity of *Hippuris*, support the view of Polunin (1959) that *H. maritima*, *H. montana* and *H. tetraphylla*, which were distinguished by American botanists on the basis of leaf shape and number of the leaves per whorl, should be considered as phenotypic variations of *H. vulgaris* L. However, our populations are highly plastic and show great variations in size and vegetative parts depending upon the habitat in which they grow; some of the variations also appear due to certain edaphic factors such as high and low concentration of nutrients present in the habitat. It therefore seems unjustified to give taxonomic recognition to these variants as species.

ACKNOWLEDGEMENTS

I thank Principal Sarwar Hussain and Prof. Hussain Ahmad, Head, Botany Dept. for providing laboratory facilities.

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34. *BOTHRIOSPERMUM TENELLUM* (HORNEM.) FISCH. ET MEY. (BORAGINACEAE) — A NEW RECORD FOR KASHMIR HIMALAYA

(*With a text-figure*)

During studies on the flora of Sind Valley, Kashmir, we came across several specimens of *Bothriospermum tenellum* (Hornem.) Fisch. and Mey. growing as a common weed of cutlivation and the present communication records for the first time the occurrence of this borage from Kashmir Himalaya. The species has been briefly described and illustrated for reference. The voucher specimens have been deposited in the Herbarium, Kashmir University (KASH) and Naturhistorisches Museum, Wien.

Bothriospermum tenellum (Hornem.) Fisch. & Mey. Index Sem. Hort. Petrop. 1: 23. 1855; C. B. Clarke in Hk. f., Fl. Brit. Ind. 4: 167. 1883; Riedl in Rechinger, Fl. Iran. 48: 56. 1967; Kazmi in J. Arnold Arboretum 51: 182. 1970; Stewart, Ann. Cat. Vas. Pl. W. Pak. & Kash. 583. 1972. *Anchusa tenella* Hornem. Hort. Hafn. 1: 176. 1815; *Cynoglossum diffusum* Roxb. Fl. Indica ed. Wall. 1:7. 1824; *C. prostratum* D. Don, Fl. Nepal. 100. 1825.

Annual, prostrate, appressedly hairy herb; stems much branched, slender. Basal leaves spathulate; lower cauline leaves obovate-lanceolate, petiolate; upper lanceolate, sessile, upper most bractlike. Flowers pedicellate, axillary, lower distant, upper in racemes. Calyx ± 2 mm long, divided to the base, lobes linear-lanceolate. Corolla ± 2.5 mm long, white to bluish white, tube equalling the calyx; lobes rounded, ± patent; throat with 5 trapeziform scales. Nutlets ± 1 mm long, ellipsoid, granu-

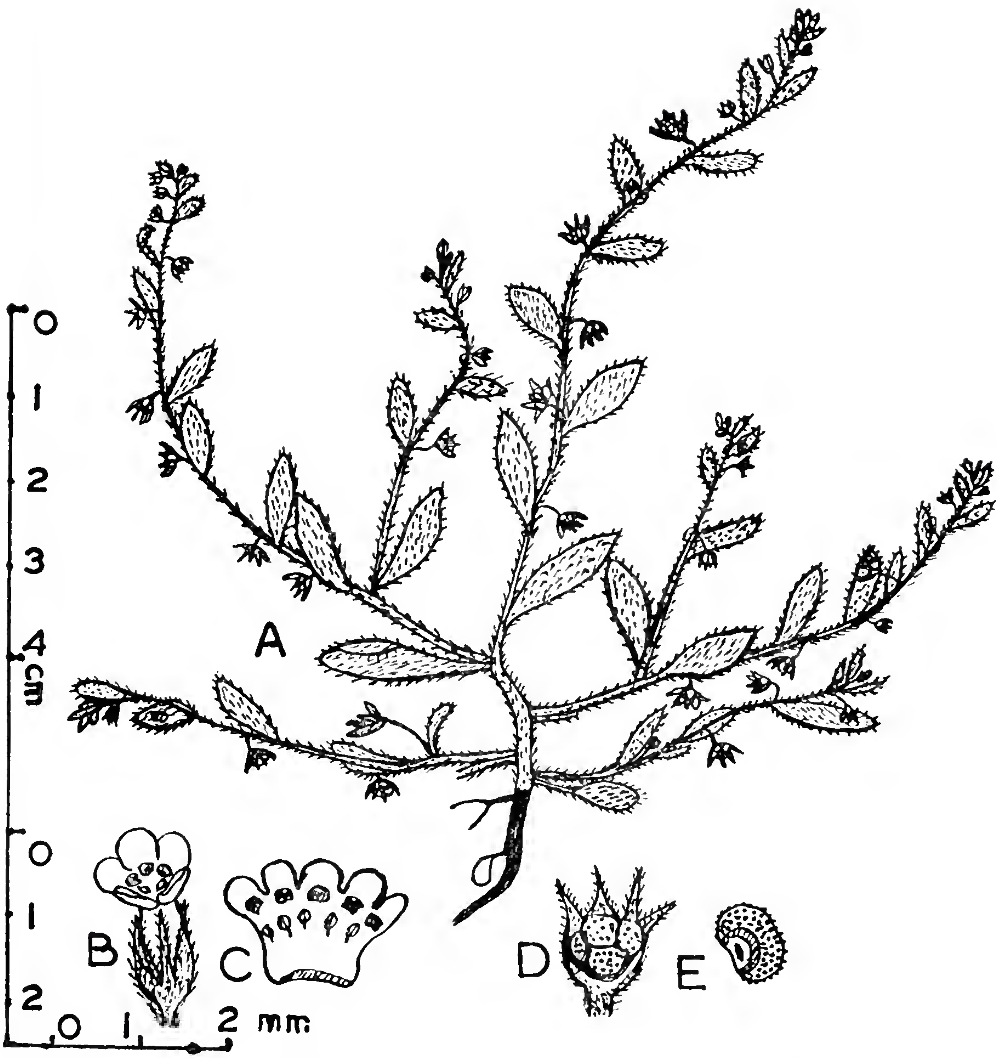

Fig. 1. *Bothriospermum tenellum* (Hornem.) Fisch. & Mey.
A. Habit of Plant; B. Flower; C. Corolla opened to show the scales; D. Fruit; E. Nutlet.

lar-scabrid, inverted; scar elliptic, longitudinal.

Type: "Herb. in China" in Herb. Vahl (as *Anchusa zeylanica*).

Distribution: Pakistan, Afghanistan, China, India, Manchuria, Japan, Philippines, Mascarene and Hawaiian Islands.

Specimens examined:

Ganderbal: 1,650 m, weed of cultivation, 20.3.1981, *G. H. Dar* 560; Beehama: 1,650 m, weed in sarson crop, 12.4.1981, *G. H. Dar* 707-11; Shellabugh: 1,600 m, in shade of willow plantation, 25.4.1981, *G. H. Dar* 1040;

Ganderbal 15.5.1981, *G. H. Dar* 1546-51; 1.7.1981, 2142-47; Chatterhama: 1,700 m weed in sarson crop, 5.6.1983, *G. H. Dar* 3597-5404; Khimber: 1,700 m, weed in pea crop, 5.6.1983, *G. H. Dar* 5405-10; Hadorah: 1,650 m, 5.6.1983, *G. H. Dar* 5411-16 (All placed in KASH).

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June 18, 1984.

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35. *CYATHEA ALBOSETACEA* (BEDD.) COPEL. — A LITTLE KNOWN ENDEMIC TREE-FERN OF NICOBAR ISLANDS, INDIA

(*With a plate & eight text-figures*)

While revising the family Cyatheaceae Kaulf. for India, some interesting data were collected on *Cyathea albosetacea* (Bedd.) Copel. a species endemic and confined to Nicobar group of Islands in Bay of Bengal. Survey of literature indicates that the species has not been described in detail so far, nor is there any illustration (cf. Beddome 1876, 1883; Kurz 1876; Holttum 1965). Recent intensive survey of Andaman & Nicobar Islands (1975-77) yielded several complete specimens of this species. Holttum (l.c.) in his revision of Asian species of *Cyathea* states that this species is "only known from type collection" and "the duplicate at K are sterile". Even though Beddome's original description contains details of sori, his type specimen should have been fertile and the type is not traceable in K or in CAL. Holttum, therefore could study only sterile specimens and he states that "the only difference from Beddome's description concerns bullate scales on costules". He further states that Beddome describes the scales as having a hyaline setaceous point at apex which he could not discover in the specimens available at Kew. Holttum believes that Beddome saw a bullate scale overlying on as ordinary hair and hence mistook it for a setaceous appendage terminal to the bullate scale.

A study of the recent material from Nicobar Islands under binocular dissecting microscope clearly showed that Beddome was correct in his observations. The bullate scales do have a sac-like, whitish basal portion and a terminal uniseriate, multicellular hairy tip which is easily detachable and hence caducous. Probably Holttum could not discover this hairy tip in the old specimens at Kew as they must have fallen away being caducous. Beddome was not accurate in describing that the hairy tip was hyaline and setaceous. They are uniseriate, subulate, delicate and similar to the normal

hairs present on the lower surface of costule. Probably the bullate scales are a modification of normal hairs with an enlarged basal bulbous portion. It was also observed that such bullate scales are more abundant in sterile pinnules than in fertile ones.

The species is described below:

Cyathea albosetacea (Bedd.) Copel. Philip. Journ. Sci. ser. C (Bot.), 4: 55. 1909; *Alsophila albosetacea* Bedd., Ferns Brit. India, Suppl. 2. 1876; Handb. Ferns Brit. India 16. 1883.

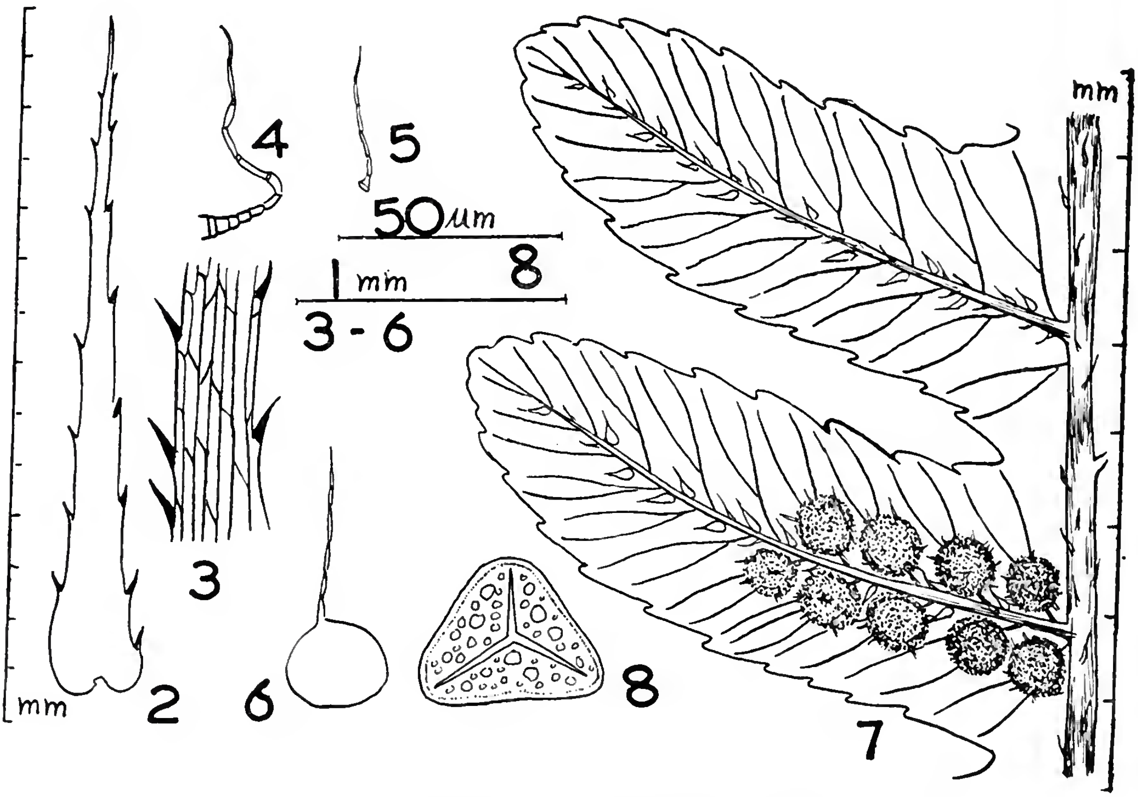
Trunk 5-10 m high, 15-20 cm in diam.; fronds 2.5-5 m long; stipe stramineous to dark brown, bearing many short spines and scattered scales. Scales setiferous, 5-10 x 1-2 mm, dark-brown, setae small, Pinnae upto 1m long;

Fig. 1. *Cyathea albosetacea* (Bedd.) Copel. Habit, *Bhargavan* 5033 (PBL).

pinna-rachis pale to dark-brown, finally warty to spinulose, clothed with hairs and narrow shining scales upto 10 mm long, scales usually smooth to sparsely setiferous. Pinnules 10-13 x 2-2.5 cm, sessile, acuminate, lower ones 1-2 basal segments almost free rest of pinnules almost lobed to costa; costules, 5-7 mm apart, veins 9-10 pairs usually forked, rarely more than once forked, thin but firm in texture, margin crenate. Sori copious, along costules upto 2/3rd part, scales and hairs present on the lower surface of costae and costules, hairs uniseriate, multicellular, whitish; bullate scales sac-like, whitish, with a very narrow uniseriate, multicellular, caducous hairy tip, abundant on the lower surface of costules, particularly more abundant on the lower surface of sterile pinnules. Spores pale, trilete, 40-45 μm in diameter, verrucoid. (Plate I; Figs. 1-8).

Ecol.: Scattered in dense tropical evergreen rain forest along stream banks and river sides in wet area and also in pandanus forests.

Specimens examined: (all specimens housed in PBL & CAL) SOUTH NICOBARS, Great Nicobar Island, 6 Km on East-West Road, ± 75 m, 19.8.1975, *Balakrishnan* 2959; East-



Figs. 2-8. *Cyathea albosetacea* (Bedd.) Copel.
2. Rhizome scale — an outline; 3. Details of rhizome scale from the middle; 4. Small thick-walled developing scale from costae; 5. Hair from costule! 6. Bullate scale with hairy tip; 7. Pinnules; 8. Proximal part of the spore.

Cyathea albosetacea (Bedd.) Copel. growing in Great Nicobar Islands.

West Road, ± 85 m, 24.7.1976, *Balakrishnan* 3998; NORTH NICOBARS, Kamorta Island, ± 15 m, 22.5.1977, *N. Bhargava* 5033.

ACKNOWLEDGEMENTS

Thanks are due to Dr. M. P. Nayar, Director, Botanical Survey of India, Howrah for encouragement and to Dr. N. P. Balakrishnan, Deputy Director, Central Circle, Botanical Survey of India, Allahabad for going through manuscript, helpful suggestions and facilities. Thanks are due to Dr. J. L. Ellis, Regional Botanist, Andaman and Nicobar Circle, Port Blair, for providing the photograph of tree fern growing in its habitat. Thanks are also due to Mr. M. A. Siddique, Photographer for the photograph of voucher specimen.

R. D. DIXIT
A. K. TRIPATHI

BOTANICAL SURVEY OF INDIA,
CENTRAL CIRCLE,
ALLAHABAD-211 002,
December 17, 1984.

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36. NOTES ON FERNS OF MAHARASHTRA

During the course of our studies on the 'Flora of Savantwadi Taluka' (Sindhudurg district, Maharashtra), we collected 61 species of ferns and fern allies. The present communication reports newly recorded distributions of 10 species from Savantwadi and one [No. 4 — *Aleuritopteris rufa* (Don) Ching] from Wada, in Maharashtra. All materials are deposited in the Blatter Herbarium. They were identified with the help of standard reference books, and checked with authentic specimens at Central National Herbarium, Calcutta (CAL). Further the identity was confirmed, wherever possible, from experts. Eleven species, namely *Selaginella ciliaris* (Retz.) Spreng, *Selaginella reticulata* (Hook. et Grev.) Spreng., *Acrostichum aureum* Linn., *Aleuritopteris rufa* (Don) Ching., *Schizolegnia heterophylla* (Dry.) Alston., *Dicranopteris linearis* (Burm. f.) Underwood, *Cyclosorus gongylodes* (Schkr.) Link., *Spaerostephanos cucullatus* (Blume) comb. nov., *Asplenium formosum* Willd., *Pleocnemia membranifolia* Presl., and *Bolbitis kanarensis* Nair et Chandra, have been recorded from present limits of Maharashtra for the first time. Since these ferns are described elsewhere, we give reference to their descriptions and distribution and other relevant data here:

1. **Selaginella ciliaris** (Retz.) Spreng, in Bull. Ac. Brux. 10: 231, 1843; Alston, in Proc. Nat. Inst. Sci. India 11: 227, 1945. *Lycopodium ciliare* Retz. Obs. 5: 32, 1789.

Found on hill slopes on wet rocky surfaces and on embankments and sometimes on sides of drying rice-fields.

Localities: Charatha, Majgaon, Otavane, Vetye, Savantwadi. *Spore formation*: November-December. *Exsiccata*: S. M. Almeida — 3630, 4614; M. R. Almeida — 828 (BLAT).

2. **Selaginella reticulata** (Hook. et Grev.) Spreng. in Bull. Ac. Brux. 10: 233, 1843; Alston, in Proc. Nat. Inst. India 11: 228, 1945. *Lycopodium reticulatum* Hook. et Grev. in Hook. Bot. Misc. 2: 402, 1831.

Grows on and in crevices of rocks and in hard rocky soils on hill-slopes. Plants of this species grow together and are found in groups. Baker (1887) has placed this species in synonymy of *S. proniflora* (Lamk.) Baker, but Alston (1945) has treated it as a distinct species. Our findings agree with Alston's view. The two allied species can be easily distinguished by their size and colour differences in dried specimens, but they resemble each other in all morphological characters, when fresh.

Localities: Charatha, Aronda, Danoli, Otavane, Savantwadi. *Spore formation*: October-November. *Exsiccata*: S. M. Almeida — 311, 748, 1392, 4631.

3. **Acrostichum aureum** Linn. Sp. Pl. 2: 1069, 1753; Beddome, Ferns South India 69, t. 204, 1863; Clarke, in Trans. Linn. Soc. London 2: 582, 1880; Beddome, Handb. Ferns Brit. Ind. 440, f. 268, 1853; Gray, in Gazett. Bomb. Pres. 376, 1886; Blatter & d'Almeida, Ferns of Bombay, 191, 1922.

Collected from tidal zones from Aronda, Satarda and Tiroda-Savantwadi.

Spore formation: Throughout the year. *Exsiccata*: S. M. Almeida 2294, 3446, 4500.

4. **Aleuritopteris rufa** (Don) Ching, Hong Kong Nat. 10: 200, 1941. *Cheilanthes rufa* Don, Prodr. Fl. Nepal. 16: 18, 1828; Clarke, in Trans. Linn. Soc. London 2 (bot. 1): 457, 1800; Hope in Journ. Bombay Nat. Hist. Soc. 13(2): 247, 1890.

There is only one specimen of this species in Blatter Herbarium (BLAT) collected by G. M. Woodrow from 'Wada'. There is one Wada in Raigad (Old Colaba) district and another Wada near Mahabaleshwar, in Satara district. There is no clear indication from which 'Wada' the specimen originated.

Spore formation: October. *Exsiccata*: Woodrow, s. n.

5. **Schizolegnia heterophylla** (Dry.) Alston, in Bot. Soc. Broter, Ser. 2, 30: 24, 1956; Pichi Sermolli, in Index Fil. Suppl. 4: 271, 1965. *Lindsaea heterophylla* Dry. in Trans. Linn. Soc. 3: 41, t. 8, f. 1, 1797. *Schisoloma heterophylla* (Dry.) J. Sm. in Journ. Bot. 3: 414, 1841; Beddome, Ferns of South India 9, t. 26, 1863 & Handb. Ferns Brit. Ind. 80, 1883; Blatter in Journ. Bombay Nat. Hist Soc. 18 (3): 603, 1908; Blatter & d'Almeida, Ferns of Bombay, 55, 1922.

Quite common fern in shady places on moist embankments and on river banks at Charatha.

Spore formation: October-April. *Exsiccata*: S. M. Almeida — 131, 1308, 2580, 5155.

6. **Dicranopteris linearis** (Burm. f.) Underwood, in Bull. Torrey Bot. Club, 34: 249, 1907; Holttum, Fl. Malesiana Ser. 2, 68, 1954. *Polypodium linearis* Burm. f. Fl. Ind. 235, t. 67, f. 2, 1768. *Gleichenia linearis* (Burm. f.) Clarke, in Trans. Linn. Soc. London 2 (bot. 1): 428, 1880; Beddome, Hand. Ferns of Brit. India 4, f. 1. 1883.

Rare, at Talkhamba and Charatha (Savantwadi) in white loamy soil on margins of rice-fields.

Spore formation: December-February. *Exsiccata*: S. M. Almeida — 1385, 4347; M. R. Almeida — 392 (BLAT).

7. **Cyclosorus gongylodes** (Schkr.) Link. Hort. Berol. 2: 128, 1833; Ching, Bull. Fan. Mem. Inst. Biol. 8: 186, 1939. *Aspidium gongylodes* Schkr. Krypt. Gew. 1: 193, t. 339, 1809.

Rare, but locally common and abundant fern at Asniye, Savantwadi. This species is included in Ferns of Brit. India by Beddome (1883) and in Ferns of Bombay by Blatter &

d'Almeida (1922), under *Nephrodium unitum* Beddome (non R. Br. 1810). It was reported from North Kanara, Dharwar from Bombay Presidency, and Goa.

Spore formation: February. *Locality*: Asniye. *Exsiccata*: S. M. Almeida: 5142.

8. **Spaerostephanos cucullatus** (Blume) comb. nov. *Aspidium cucullatum* Blume, Enum. Pl. Jav. 151, 1826. *S. unitus* (Linn.) Holttum, in Journ. South Afric. Bot. 40: 165, 1974. *Polypodium unitus* Linn. Syst. Nat. (ed. 10) 2: 1326, 1759 (Excl. syn.).

Rare, but locally common fern on sides of streams at Asniye, Savantwadi, along with preceding species. Several specimens of this species from North Kanara in the Blatter Herbarium have been identified by Professor R. E. Holttum.

Spore formation: February-March. *Locality*: Asniye. *Exsiccata*: S. M. Almeida — 5140.

9. **Asplenium formosum** Willd. Sp. Pl. 5: 329, 1910; Beddome, Ferns of South India, 46, t. 136, 1863 & Handb. Ferns. Brit. India, 152, 1883.

Rare species, only found at one locality growing on rock-face in a shady place, along Amboli Ghat. The fern remains dried and curled throughout the year except for the period of monsoon when the rock remains wet.

Spore formation: September-October. *Exsiccata*: S. M. Almeida — 1954; M. R. Almeida — 274 (ALC).

10. **Pleocnemia membranifolia** Presl. in Rel. Haenk. 36, t. 5, f. 3, 1836; Beddome, Handb. Ferns of Brit. India 225, 1883.

Rare, found on embankments along sides of a stream near Tamboli, Savantwadi. Blatter & d'Almeida (1922) have only reported this species from North Kanara.

Spore formation: April-May. *Locality*: Tamboli. *Exsiccata*: S. M. Almeida — 5156.

11. **Bolbitis kanarensis** Nair et Chandra, Amer. Fern Journ. 54 (1): 9, 1964.

The distinguishing characters of this species are tetragonal stipes and bulbiferous fertile fronds, by which it differs from *Bolbitis subcrenata* (Hook. et Grev.) Ching. These characters are not very reliable in separation of the species in this genus. In all the species of *Bolbitis*, the stipes tend to assume angular nature and very often they are ribbed along their whole length. Apical bulbils are a common feature in *Bolbitis subcrenata* (Hook. et Grev.) Ching.

There is one specimen in Blatter Herbarium from Khandala, which matches with the description and the photograph of the only type sheet in the herbarium of National Botanic Research Institute, Lucknow (NBG).

Spore formation: April. *Exsiccata*: H. Santapau — 400.

Besides the above mentioned eleven species, *Ampelopteris prolifera* (Retz.) Copel. was collected from Otavane, Banda, Burdi, Bhedsi-Savantwadi (SMA — 1795, 4318; MRA — 393), from river banks, in sandy soils, and among rocky boulders sometimes partly submerged under water. *Bolbitis presliana* (Fee) Ching ex Christensen, was collected from Danoli, Amboli and Hiranyakeshi-Savantwadi (SMA — 4831, 5152; MRA — 870), along the margins of stream on wet rocks. *Lygodium microphyllum* (Cav.) R. Br. was collected from Danoli, Kesri and Asniye-Savantwadi (SMA — 1539, 5139), along streams. Baltter & d'Almeida (1922) have mentioned all these ferns from Konkan without any precise localities.

Nephrolepis exaltata (Linn.) Schott. was found wild and naturalized at Tamboli-Savantwadi, along streams in wild state (SMA — 5142).

Lycopodium hamiltonii Spreng. has been so far known to occur at Wada near Mahabaleshwar, but we have collected it from Amboli plateau (MRA — 2524), epiphytic on *Eugenia* and *Memecylon* trees.

Savantwadi is the type locality for two newly described taxa *Pteris almeidiana* Bole & Almeida and *Pteris savantwadiensis* Bole & Almeida.

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37. A CONTRIBUTION TO THE ALGAE OF SAHASTRADHARA, DEHRADUN (U.P.)

The present paper deals with the algal flora of Sahastradhara, Dehradun (Uttar Pradesh). Sahastradhara is 14 Kms. away from the main city of Dehradun. It is famous as a picnic spot for its natural beauty and cold sulpher water springs.

Algal samples were collected in October, 1982 and preserved in 4% formaldehyde for further observations. Algal forms were taken from the rocks and picked up from the flowing streams. In all 57 taxa have been recognised, of which 23 taxa belong to Bacillariophyceae, another 23 taxa to Cyanophyceae and the remaining 11 taxa to Chlorophyceae.

The measurements of length, width, etc. of the taxa are given in microns (μm). The following abbreviations are used in the text. Length ...... L. Width ...... W. Isthmus ...... I. Striae ...... S. Diameter ...... D.

ENUMERATION OF TAXA

CYANOPHYCEAE

1. *Microcystis pulverea* (Wood) Forti
   Cells D. 2-2.5.
2. *Chroococcus minutus* (Kutz.) Nag.
   Cells D. 11-14 (with sheath), 7-9 (without sheath).
3. *Chr. turgidus* (Kutz.) Nag. var. *maximus* Nygard
   Cells D. 26 (with sheath), 9-10 (without sheath).
4. *Gloeocapsa atarta* (Turp.) Kutz.
   Cells D. 8-10 (with sheath), 3-5 (without sheath).
5. *Aphanocapsa biformis* A. Br.
   Cells D. 4-5.
6. *Aphanothece pallida* (Kutz.) Rabenh.
   Cells L. 10-11; W. 5-7.
7. *A. saxicola* Nag.
   Cells L. 5; W. 2.
8. *Synechococcus aeruginosus* Nag.
   Cells L. 7; W. 5.
9. *Spirulina laxissima* West, G. S.
   Cells W. 1; spirals distant 22.
10. *S. major* Kutz. ex Gomont
    Cells W. 2; spirals distant 4-5.
11. *S. meneghiniana* Zanard. ex Gomont
    Cells, W. 2; spirals distant 4.

12. *Oscillatoria tenuis* Ag. ex Gomont
L. 4-5; W. 2-3.
13. *O. amphigranulata* Van Goor
L. 2.5; W. 2.
14. *O. amphibia* Ag. ex Gomont
L. 5; W. 3.
15. *Phormidium foveolarum* (Mont.) Gomont
L. 1-1.5; W. 1.5-2.
16. *P. usterii* Schmidle
L. 3; W. 3-4.
17. *Lyngbya contorta* Lemm.
L. 3.5-4; W. 2.
18. *Symploca flaccida* Zanardini
L. 3-4; W. 8-10 (with sheath), 2.5-3 (without sheath).
19. *Nostoc linckia* (Roth) Bornet ex Born. et Flah.
Cells D. 4-5; spores D. 7-9.
20. *N. piscinale* Kutz. ex Born. et Flah.
Cells D. 4-6; spores D. 6.
21. *N. ellipsosporum* (Desm.) Rabenh. ex Born et Flah.
Cells L. 8-9; W. 5-6; spores L. 15-16; spores W. 6-7.
22. *N. verrucosum* Vaucher ex Born. et Flah.
Cells D. 2-4; spores D. 6-7; heterocyst D. 4.
23. *Anabaena laxa* (Rabenh.) A. Br.
Cells L. 6; W. 4-5; spores L. 15-16; spores W. 7-8.

Chlorophyceae

24. *Mougeotia* sp.
Veg. Cells L. 90-100; W. 7-9.
25. *Spirogyra* sp. I.
Veg. Cells L. 140-150; W. 20-25.
26. *Spirogyra* sp. II.
Veg. cells L. 130-135; W. 48-50.
27. *Cladophora glomerata* (L.) Kutzing
Veg. cells. L. 150-200; W. 16-45.
28. *Tetraedron minimum* (A. Braun) Hansgirg
Cells quadrangular, W. 6-7.
29. *Cosmarium moniliforme* (Turp.) Ralfs.
L. 20-23; W. 12-14; I. 4-5.
30. *C. subcucumis* Schmidle
L. 45-50; W. 28-32; I. 8-10.
31. *C. speciosum* var. *simplex* Nordst.
L. 30-34; W. 19-22; I. 6-7.
32. *C. contractum* Kirchn.
L. 22-25; W. 16-18; I. 3-4.5.
33. *C. subgranatum* (Nordst.) Lutkem. var. *subgranatum* Krieg. & Gerl.
L. 17-20; W. 13-15; I. 4-5.
34. *Euastrum insulare* (Wittr.) Roy
L. 10-12; W. 8-10; I. 2.

Bacillariophyceae

35. *Cocconeis placentula* Ehr.
L. 26-28; W. 14-15; S. 22 in 10 μm.
36. *Cyclotella* sp.
Cells D. 36-40; S. 8 in 10 μm.
37. *Cymbella symbiformis* C.A. Agardh
L. 40-43; W. 9-10; S. 10-11 in 10 μm.
38. *C. mulleri* Hust.
L. 100-104; W. 26-28; S. 7-8 in 10 μm.
39. *C. ventricosa* Kutz.
L. 30-32; W. 9-10; S. 10-11 in 10 μm.
40. *C. tumescens* A. Cl.
L. 32-33; W. 7-8; S. 10-11 in 10 μm.
41. *C. rupicola* Grun.
L. 34-36; W. 10-11; S. 12-13 in 10 μm.
42. *Cymbella* sp.
L. 45-48; W. 10-11; S. 9-10 in 10 μm.
43. *Amphora veneta* (Kutz.) Hust.
L. 28-30; W. 7-8; S. 18-19 in 10 μm.
44. *Amphora* sp. I.
L. 55-57; W. 10-12; S. 10-12 in 10 μm.
45. *Amphora* sp. II.
L. 35-37; W. 7-8; S. 20 in 10 μm.
46. *Synedra ulna* (Nitxsch.) Ehr.
L. 110-120; W. 7; S. 9 in 10 μm.
47. *S. ulna* var. *aequalis* (Kutz.) Hust.
L. 100-105; W. 6; S. 9 in 10 μm.

48. *S. rumpens* Kutz. var. *fragilarioides* Grun.
L. 42-45; W. 3; S. 10 in 10 μm.
49. *Navicula pupula* Kutz.
L. 28-30; W. 8; S. 25 in 10 μm.
50. *N. pupula* Kutz. var. *capitata* Hust.
L. 35-36; W. 7.5-8; S. 24-25 in 10 μm.
51. *N. pupula* Kutz. var. *rectangularis* (Greg.) Grun.
L. 35-36; W. 8-9; S. 23-24 in 10 μm.
52. *N. viridula* Kutz.
L. 70-75; W. 17-19; S. 9-10 in 10 μm.
53. *N. viridula* Kuta. var. *rostellata* (Cleve) Meister
L. 45-46; W. 8-10; S. 11-12 in 10 μm.
54. *Gomphonema aequatoriale* Hust.
L. 32-34; W. 7.5-8; S. 10-11 in 10 μm.
55. *G. olivaceum* (Lyngb.) Kutz. var. *calcarea* Cleve
L. 54-56; W. 10-12; S. 11-12 in 10 μm.
56. *Tabellaria* sp.
L. 42-44; W. 13-14; S. 10-12 in 10 μm.
57. *Nitzschia* sp.
L. 38-40; W. 13-15; S. 10-11 in 10 μm.

ACKNOWLEDGEMENTS

I am grateful to Dr. U. C. Bhattacharya, Deputy Director, Northern Circle, Botanical Survey of India, Dehradun for encouragement and to Dr. N. P. Balakrishnan, Deputy Director, Central Circle, Botanical Survey of India, Allahabad for providing facilities for the work. Thanks are due to Dr. R. D. Dixit, Regional Botanist, Central Circle, Botanical Survey of India, Allahabad for valuable suggestions.

ANIL KUMAR TRIPATHI

BOTANICAL SURVEY OF INDIA,
CENTRAL CIRCLE,
ALLAHABAD,
July 10, 1984.

ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR 1983-84

HONORARY SECRETARY'S REPORT FOR THE YEAR 1983
CENTENARY YEAR REPORT

The Society completed the first hundred years of its existence in 1983. For a Society maintained largely out of revenues derived from its membership subscriptions and from those generated through its publications it is indeed a creditable achievement, particularly when it is realised that the endeavours that brought the Society to its present level of international recognition is mainly through the time and effort put in by its members in an honorary capacity.

As we had advised in our eariler reports, the Centenary Celebrations related to the main activities of the Society in the form of preparation and release of special publications, an audio visual on the Society, a photographic exhibition, an educational snake exhibition and a scientific seminar on conservation in developing countries.

The Centenary Year commenced with an inaugural function on the 15th September 1983, the date on which the Society was constituted a hundred years ago by eight residents of Bombay. The Prime Minister of India, Mrs. Indira Gandhi, who is also the Patron of the Society graced the occasion and released the Society's Centenary Publications, A PICTORIAL GUIDE TO THE BIRDS OF THE INDIAN SUB-CONTINENT by Sálim Ali & Dillon Ripley with plates by John Henry Dick, and A CENTURY OF NATURAL HISTORY — a selection of natural history articles from the Society's Journal edited by J. C. Daniel.

The stamp on the Society brought out by the Philatelic Bureau of the Post & Telegraphs Department was also released by the Prime Minister.

The highlight of the inaugural function was the grant of 33 acres of land to the Society at Goregaon, adjoining the Sanjay Gandhi National Park by the Government of Maharashtra for an establishment for the Society's field research activities.

The second event of importance was the Educational Snake Exhibition which was organised at the Cross Maidan between 12th November & 18th December and attracted over 2,06,000 visitors including 20,000 school students.

The Centenary Seminar arranged at IIT Powai from 6th to 11th December 1983 on 'Conservation in Developing Countries — Problems and Prospects' was inaugurated by Shri Digvijaysinh, Deputy Minister for Environment, Government of India. More than three hundred delegates from abroad and India including Research Staff of the Society attended. Ninety four papers were presented on different aspects of conservation research and several resolutions covering conservation problems were passed on the concluding day.

The Centenary Photography exhibition held at the Jehangir Art Gallery from 21st to 26th December 1983, was inaugurated by Air Chief Marshal I. H. Latif, Governor of Maharashtra. More than ten thousand visitors saw the exhibition.

MEMBERSHIP

Although the fact that there has been a steady increase in membership in recent years is of some satisfaction, there is considerable room for further enlarging the membership and

we seek the assistance of our members in this endeavour.

We are continuing our effort to increase the several categories of membership particularly the Compound Corporate membership. The Society cannot be completely independent in finance and activities till its membership covers its establishment and other costs.

Details of membership for the past quinquennium, showing members fully paid up on 31st December of each year are given in the statement below:

Hornbill:

The Hornbill continued to retain its popular appeal and to attract new members. We again request members to remember that the Hornbill is largely a reflection of member talent. If you have good material in the form of articles and photographs, remember to share the happiness you had in your treks and rambles with other members through your articles and photographs in the Hornbill. Its continued publication is possible if members assist the staff in securing advertisements which can partially bear the cost of publication.

	1979	1980	1981	1982	1983
Ordinary members	660	764	1044	1137	1533
Corporate members	180	168	176	162	158
Life members	305	327	349	407	484
Compound Corporate members	9	20	37	52	102
Student members	83	94	165	126	182
Honorary members	4	3	3	3	3
Vice Patrons	–	–	3	4	4
	1241	1376	1777	1891	2466

Members elected in 1983 but not paid	17
Members paid for 1982, but not paid for 1983	205

Publications

Journal:

During the year the August and December issues for 1982 Vol. 79 (2) & (3) and the April issue for 1983 Vol. 80 (1) were published. During the year 230 articles and notes were received for publication in the Journal. However 80th volume of the Journal for the year 1983 was delayed from the involvement of the staff in other Centenary Year activities of the Society.

THE BOOK OF INDIAN BIRDS continues to be the Society's most popular publication. Publications are the one endeavour of the Society which has consistently retained its high quality and makes available books on natural history at a fraction of the cost of books published by commercial organisations. In the Centenary Year two more prestigious publications were added to the Society's list of publications namely A PICTORIAL GUIDE TO THE BIRDS OF THE INDIAN SUB-CONTINENT and A CENTURY OF NATURAL HISTORY.

	Sales in 1982	Sales in 1983	Balance stock 31-12-1983
The Book of Indian Birds	2019	2067	1519
The Book of Indian Animals	613	710	1178
Some Beautiful Indian Trees	188	292	1506
Glimpses of Nature in India Booklet	393	548	667
Snake Chart	27	27	319
Checklist of the Birds of Maharashtra (2nd edition)	107	130	1634
Checklist of the Birds of Delhi, Agra & Bharatpur	30	153	53
A Synopsis of the Birds of India & Pakistan	386	103	1583
Some Beautiful Indian Climbers & Shrubs	335	187	2370
Grasses of Western India	55	95	324
A Pictorial Guide to the Birds of the Indian Sub-Continent	—	338	3153
A Century of Natural History	—	263	30*

* Received from Press 293 copies

CHECKLIST OF THE BIRDS OF BORIVLI NATIONAL PARK by Humayun Abdulali published by the Society is on sale at the Sanjay Gandhi National Park, Borivli, Bombay. It is also available at the Society's office.

Books under preparation:

ENCYCLOPEDIA OF INDIAN NATURAL HISTORY
Centenary Publication 1883-1983

It has not been possible to publish the Encyclopedia in the Centenary Year. Work is in progress and when published the Encyclopedia will be priced at a level which would enable it to be available as a ready reference volume for students in schools and colleges and to the general reader on the natural history of the Indian region.

THE BOOK OF INDIAN REPTILES
By J. C. Daniel

One in the continuing series of the Society's publications on Indian Natural History, the Reptile Book describes the common reptiles of the Indian Sub-Continent. The snake section will be illustrated with the paintings which originally illustrated Wall's *A popular treatise on the common Indian Snakes.*

THE BOOK OF INDIAN TREES

Arrangements are being made for the preparation of this book by Prof. J. N. Sahni. About 150 common trees in India will be described and illustrated.

CONSERVATION

The Society continues to be recognised by the Central and State Governments in India

and by International Organisations abroad as an authoritative source for information on conservation of wildlife and natural resources. This recognition is expressed in the form of association of its officials with State and Centrtal Wildlife Advisory Boards and representation on the Specialist Groups of the Species Survival Commission of the International Union for the Conservation of Nature and Natural Resources.

Members' Activities

Bird count:

The monthly roadside count of birds at the Borivli National Park on the third Sunday of each month was continued. The main purpose of the bird counts is to get members interested in bird study and the accurate recording of data. The information collected gave an indication of local movements of birds. Attempts are now being made to teach the collection of phenology and other environmental data for correlation.

Nature walks:

Nature walks were held in various areas of natural history interest around Bombay for birdwatching, vegetation, butterflies study. The programme helped in recruiting new members and fostering interest in natural history among members.

Research and other activities funded from field work funds

The field work funds avaialble at the Society supported the following activities:

Sálim Ali Nature Conservation Fund:

(1) *Blacknecked Crane in Ladakh*: Mr. S. A. Hussain, Project Scientist, BNHS, Mr. Prakash Gole of the WWF-India, and Vice Admiral M. P. Awati, IN (Retd.), a keen member of the Society visited Ladakh and other areas for a status survey of Blacknecked Crane.

The Blacknecked Crane is perhaps the only crane in the world having an exclusive distributional breeding range between the altitudes of 3500 m to 5500 m in the table lands of central Asia, and also an equally unique migratory pattern. Breeding and passage area seem to overlap along a crescentic tangent from Ladakh up to lower hills of north eastern India, skirting the northern faces of Himalayas along the southern approaches of the Tibetan Plateau. The present status of the cranes is based on a series of exploratory forays into Ladakh initiated by the Joint BNHS —WWF expedition to Ladakh in 1976 and followed by two more and a third to their wintering quarters in Bhutan.

The aims & objectives of the present survey were:

(a) To determine how many pairs Blacknecked Cranes actually broad in Ladakh
(b) The breeding success
(c) Whether it is feasible/advisable to collect eggs for captive breading and
(d) To gather information on the breeding biology and behaviour of the Blacknecked Cranes in Ladakh.

The evidence so far gathered suggests that the population Blacknecked Crane in Ladakh has been constant for the past 50 years. One pair each nests in Chushul, Hanle and Tsokar while unmated singletons also visit these areas. There are possibilities of cranes occurring in the southern edge of Tso Morari but definite evidence is not available. It is now obvious that

Ladakh is a peripheral breeding ground for the Blackneeked Cranes and a larger and more suitable areas exist in the Tibetan plateau.

(2) *Blacknecked Crane Posters*: As a part of Conservation Action of the species posters of Blaeknecked Crane were prepared with an appeal to save these rare birds and were distributed among the armed forees operating in Ladakh. It is proposed to prepare more eopies of the posters for distribution among persons living or temporarily located in the habitat of the speeies.

(3) *Study of Birds in Plantations*: Introduction of commereially useful exotic trees and plantations of these trees in pure stands is a cause for eoneern as a possible souree of environmental degradation partieularly for wildlife. Mrs. Tara Gandhi has undertaken a study of the numbers and diversity of the Avifauna of plantations of eashew nut trees and euealyptus in the environs of Madras in comparison with a plot of natural vegetation. Her studies indieate that whereas the natural vegetation whieh is a serub jungle has an almost constant population, the number of birds in cashew plantation fluctuated being maximum during the flowering season, the euealyptus plantation is hardly used and is sparsely used by a limited number of birds both in species and numbers. The study continues.

(4) *Wild Buffalo Survey*: Mr. H. K. Divekar was given assistanee for a survey of the status of the wild buffalo in Bustar.

One of the most endangered fauna of India is the Peninsular India population of the Wild Buffalo presently restrieted to Bastar and nearby areas of Madhya Pradesh and Orissa. The survey by Mr Divekar was negative in results and draws attention to the precarious situation of the species.

Sálim Ali-Loke Wan Tho Ornithological Research Fund:

(1) Mrs. K. R. Lalitha submitted her thesis on the comparative biology of drongos (Family Dicruridae, Class Aves) with special reference to ecological isolation, the result of a three year study at Periyar Sanetuary on species of drongos, the Raeket-tailed, the bronze, the grey and the white four bellied drongos.

The study established that coexisting species of drongos have evolved different methods for redueing competition, such as differenee in prey size, preferred feeding strata, feeding aetivity rhythm, speed and distanee of feeding flight, breeding habitat, breeding territory and also by winter or loeal migration. The findings support the prineiple of ecological isolation of closely allied speeies.

(2) Mr. Shahid Ali eontinued the study of the Eeology of the Grey Partridge at Point Calimere in Tamil Nadu.

The grey partridge or francolin (*Francolinus pondicerianus*) one of five asian franeolins is the most widely distributed in the Indian subeontinent. It extends eastwards from eastern Arabia, adopting to several very diversified habitats through Afghanistan, Iran, West Pakistan and the Indian peninsula in serub, cultivation, and edges of light forest. It superficially resembles a medium-sized domestic chicken, its drab brown plumage barred dorsally with ehestnut and wavily pencilled in black ventrally, not conspieuous till it flies, the robust body, rounded, cambered wings and swift flight, together with its chestnut

tail is then diagnostic. A very social species, it forms coveys when not nesting; its various high-pitched ringing calls are typical of the Indian countryside.

(3) Mr. Anwarul Islam from Bangladesh completed his observations on the Ecology of the Laughing Thrushes in the Himalayas and the Western Ghats.

About 30 species of Laughing Thrushes occur in the Indian sub-continent mainly in the Himalayas. However, two species *Garrulax cachinnans* and *Garrulax jerdoni* are endemic to the south Indian hills. An intensive study was made of the ecology of the two endemic laughing thrushes in the Nilgiris (*G. cachinnans*) and Palni Hills (*G. jerdoni*) from May 1982 to mid March 1983 and July 1983 to June 1984. For obtaining comparative data on habitat preference, food and feeding habits and breeding ecology, four months (March-June 1983) were spent around Nainital in the Western Himalayas. Four species of Laughing Thrushes, viz. *Garrulax lineatus*, *G. albogularis*, *G. striatus* and *G. leucolophus* were studied in the Himalayas. The study continues.

Pirojsha Godrej Fund:

Financial assistance was provided to:

(1) Nisarg Shikshan Yatra — As. 5000.

The Nisarg Shikshan Yatra or Nature Education Trek was arranged from the 29th October to 7th November 1983 in Raigad, Ratnagiri and Sindhudurg districts of Konkan region of Maharashtra as a part of the Nature Education Scheme for rural areas during the Centenary of the BNHS. Twenty seven volunteers participated in the Yatra (21 members, 4 Lok Vidnyan Sanghatana volunteers, 2 State Bank staff).

Prior to the Yatra, letters were written to schools and social organisations in the region and there was good response from most of them and accordingly arrangements were made.

The volunteers were divided into three groups. One group stayed at the base to arrange the exhibition, demonstrations, sale of books, nature games, slide shows and film shows, while the other two groups surveyed the ecological situation of the region particularly on the hill side and the sea shore area. This included discussions with the local people, forest department staff, timber and coal contractors etc.

The programme at base received very good response from the villagers. Exhibition and film shows were well attended. Solar cooker demonstrations attracted a large number of people and created a certain amount of enthusiasm.

In addition, an audio visual by Marathi Vidnyan Parishad (specially prepared for women and a loknatya (drama) by Lok Vidnyan Sanghatana was performed at two places.

(2) Mumbai Vigyan Yatra — Rs 1500

This educational programme was mainly aimed at teaching nature appreciation to underprivileged children who normally do not have access nor the facilities to learn and appreciate nature. Localities like Chembur, Govandi, Trombay and Parel were chosen where volunteers deputed from various organisations like ours assisted the Mumbai Vidnyan Yatra in this venture.

To make the programme enjoyable while they learnt, information was given often in the form of drama skits, films, slide shows and games. For the first time the

children saw the rings of Saturn and also the constituents of human blood. Games like the 'Web of Life' were played to illustrate the interdependence between man and nature. Slides were shown along with demonstration on live snake. The response received was overwhelmingly encouraging.

RESEARCH FUNDED BY GOVERNMENT & GOVERNMENTAL AGENCIES

Studies on the movement and population structure of Indian avifauna:

The project carried out bird ringing and related studies throughout the year in its two major field research stations in Point Calimere Sanctuary in Tamil Nadu and Keoladeo National Park in Bharatpur, Rajasthan. Apart from these seasonal ringing stations were conducted in Harike Lake, Punjab, Chilka Lake, Orissa and Kodaikanal Hills in Tamil Nadu.

At Point Calimere a multidisciplinary team of biologists also monitors the carrying capacity of the estuarine ecosystem. This includes weather data, plant phenology, insect population trend and the estuarine/marine organisms, which have a bearing on the bird populations visiting the area. The field station has collected, preserved and listed the plant, insect and other biological specimens. This will be the basis for a comprehensive baseline data for the area. So far over 205 species of birds, over 300 species of plants, over 500 species of insects belonging to 16 orders and over 100 species of marine/estuarine organisms have so far been recovered/collected from Point Calimere.

Over 52000 birds belonging to about over 150 species were ringed and released in the year 1980-83. The Spoonbilled Sandpiper a very rare species from Siberia, was the most exciting visitor to Point Calimere. Five birds were ringed during the season and almost equal number was seen in the area. Another exciting bird was a Curlew Sandpiper which was recaptured at Point Calimere on 29-8-1980, 6300 kms later, after it was ringed at Weribee, Australia on 20-11-1976.

At the Bharatpur ringing station a total of 39436 birds of about 200 species were ringed and released. Ducks and Coots comprised the largest number. Quite a number of Ducks ringed in Bharatpur were recovered in USSR. The most exciting recovery was that of a Reeve which was ringed as a juvenile in Bharatpur on 27.9.1983 and recovered in East Cape Province, South Africa on 2.1.1984 a distance of 8600 kms travelled in three months not to speak of the additional 5000 km already travelled from its breeding ground to Bharatpur.

We are also having some interesting results from the ringing data obtained at Harike and Chilka. The data will be processed and presented as soon as the analysis is carried out.

An Ecological Study of Bird Hazards at Indian Aerodromes

The Bombay Natural History Society entered into the fourth year of its association with aviation through its ecological study of bird hazards at Indian aerodromes. The study is funded by the Aeronautics Research & Development Board of the Ministry of Defence, Government of India.

The year 1983 has been a year of much activity and our small research team did considerable work in the field and in the laboratory.

Apart from Bombay, Delhi and Hindan, the research team covered four more aerodromes namely, Gwalior (1st stage May-August), Jodhpur (1st stage August-September), Trivandrum (1st stage October) and

Bangalore (1st stage, 19th October to 20th November).

We have had very good response from the air force and we have been able to identify almost all the remnants sent to us so far. We still do not receive bird remnants from the civil aviation but we hope this problem can be solved once we get the pilots and others in aviation effectively interested. The guide booklet on identification of problem birds, when published, is expected to help in this direction.

We have been urging Government to take action on recommendations in reports already submitted. It is essential that these be implemented speedily if the hazard from birds is to be eliminated.

Ecology of Certain Endangered Species of Wildlife and Their Habitats.

Great Indian Bustard:

Throughout the year, intensive studies were done at Karera in Madhya Pradesh and Nanaj Maharashtra on the Great Indian Bustard. Data on the food and feeding habits, movement, display, nesting behaviour, moult etc. was taken and the first annual report of the project based on the work done at Karera and on various surveys was published in September. The birds at Karera start breeding from March, and after this discovery and at our suggestion the Forest Department gave more protection during the breeding season as a result of which six out of nine eggs hatched. Previously, it was thought that the bustards at Karera breed at the onset of monsoon so protection was not available to the hens in summer and consequently most of the eggs were destroyed by cattle.

1983 was a very good year for the breeding of bustards at Nanaj, where their breeding is highly dependent on rainfall. We got some very interesting nesting behaviour data. Nine chicks were added to the Nanaj population of the bustard. Detailed observation of the courtship behaviour was done and some very remarkable photographs of the displaying male were obtained. Copulation was also observed which was till has not seen by any scientist.

A new population of bustards was found in Andhra Pradesh in two places i.e. Rollapadu and Baganpalli in Kurnool district. After studying the habitat preference of the bustard at Nanaj and Karera (and also in other places), remedial measures were suggested to the Ghatigaon Bustard Sanctuary in Gwalior where due to complete protection, vegetation had over grown. Kota in Rajasthan was surveyed but no bustard was seen. Nearly twenty places in Maharashtra were surveyed during the monsoon, and we saw bustards in three spots and obtained evidence of their presence from another five places.

Elephant:

The Asian Elephant survives in five disjointed populations in India. Though a fairly comprehensive picture of the status and conservation problems of the elephant in India is available, many more studies on the ecology of the elephant in different biomes are necessary to get an overview of the needs of the Indian elephant. The BNHS project is geared to this objeetive. Work commenced late in 1983 and was primarily confined to training the field researchers in observation techniques, vegetation studies, literature survey, and preparation of project proposal for field studies in different elephant habitats.

The project scientist undertook as a part of the staff training programme a survey of the Mundanthurai -- Kalakkad Hills with particular reference to food plants and range

of the species and conservation problems. 22 species of food plants were identified and recommendations prepared on elephant requirements.

Hydrobiological (Ecological) Research Station at Keoladeo Ghana National Park, Bharatpur

The Keoladeo National Park, at Bharatpur more familiarly known as the Ghana Bird Sanctuary is perhaps, one of the best wetland waterfowl habitats in the world.

The project was designed to obtain data on the hydrobiology of the park particularly in relation to the ecology of the waterfowl and the factors influencing the ecosystem. Data was collected on Meteorology, Hydrology, Physico-chemical features of water, Primary Productivity, Planktonology, Entomology (Aquatic & Land), Ichthyology, Ornithology (Census of aquatic birds, comparative ecology of residential ducks, ecology of Sarus Crane, comparative ecology of egrets, Heronry, breeding population of the purple and the Indian Moorhen, the pheasant-tailed and the bronze-winged jacana and the white-breasted water hen, Census of land birds), Botany (Aquatic vegetation, Terrestrial vegetation), Mammals, etc.

Donations

The Society is deeply grateful to the following Institutions, Organisations and Individuals for substantial donations towards the activities and welfare of the Society.

1. *Government of Maharashtra*
   (a) Grant of 13.53 ha. area of land in the Bombay suburbs towards the Society's field activities.
   (b) Special grant of Rs. 1,23,000/- towards repairs to Hornbill House.
   (c) Seminar expenses Rs. 10,000/-.
2. *Jamsetji Tata Trust*
   Rs 1,00,000/- towards the Centenary expenses.
3. *National Council of Educational Research & Training*
   Rs 90,000/- towards the Centenary Seminar.
4. *Dorabji Tata Trust*
   Rs. 50,000/- to the Sálim Ali — Loke Wan Tho Ornithological Research Fund.
5. *Grindlays Bank p.l.c.*
   Rs 40,000/- towards the organisation of the Photographic exhibition.
6. *Department of Environment, Government of India*
   Rs 25,000/- towards the Centenary Seminar.
7. *Dr. Sálim Ali*
   Rs 12,000/- to the Sálim Ali Nature Conservation Fund.
8. *Navajbhai Ratan Tata Trust*
   Rs 10,000/- towards Centenary expenditure.

The following donations were received specifically for the Centenary Fund:

	Rs. P.
M/s. Rashtriya Chemicals & Fertilizers Ltd.	7,000.00
Dr. Sálim Ali	5,000.00
Niranjan Narottam Foundation	5,000.00
Messrs. Colgate Palmolive (India) Ltd.	2,500.00
Mr. T. J. Roberts	1,600.00
Mr. H. K. Divekar	1,501.00
Mr. J. M. Power	1,490.49
Dr. B. R. Dave	1,001.00
Dr. C. V. Kulkarni	1,001.00
Mr. A. H. Patel	1,000.00
Dr. (Ms.) Hamida Saiduzzafar	1,000.00
Mr. R. E. Hawkins	1,000.00

Mrs. D. S. Variava	1,000.00
Mr. Bittu Sahgal	1,000.00
Mr. K. B. Mehta	1,000.00
	32,093.49
Donations less than Rupees thousand	74,917.93
Total	1,07,011.42

Reference Collection

During the year under reference 577 specimens were registered into the collections.

Birds	12
Reptiles	97
Amphibians	68
Botanical specimens	400

Nature Education Scheme

As a part of the World Forestry Day celebrations a paniting competition was arranged on 19th February 1983. 300 pupils from various schools in and around Bombay participated. The first prize for the three sections were distributed on 15th September 1983 by Prime Minister Mrs. Indira Gandhi at Hornbill House. Conservation stickers were made out from the first 3 paintings of each group.

A batch of 70 pupils from 3 schools in Thane attended the Gir nature camp.

During the year about 200 schools from Bombay, Thane & Kalyan were contacted for nature education activities. More than 1000 students participated in outdoor activities and another 2500 students were shown slides and films on wildlife.

Revenue & Accounts

The financial situation of the Society was satisfactory. The year's working showed a small surplus.

Staff

The Committee wishes to record its appreciation of the willing cooperation of the staff in the activities of the Society.

Regd. No. F. 244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

BOMBAY PUBLIC TRUSTS ACT, 1950
SCHEDULE VIII VIDE RULE 17(1)

BALANCE SHEET FOR THE YEAR ENDED 31 *DECEMBER*, 1983

FUNDS AND LIABILITIES

Trust Fund or Corpus:		
Life Membership Fund (individual):	248939.48	
Add: Amount received during the year	65579.85	314519.33
Corporate Life Membership Fund:		
Balance as per last Balance Sheet	72700.00	
Add: Amount received during the year	115461.31	188161.31
Vice Patron Fees:		
Balance as per last Balance Sheet		42769.00
Fixed Assets Fund:		
Balance as per last Balance Sheet	67835.36	
Less: Depreciation of fixed assets for the year transferred	11504.35	56331.01
General Reserve Fund:		
Balance as per last Balance Sheet		37952.71
Building Fund:		
Balance as per last Balance Sheet	6497.68	
Less: Transferred to Income & Expenditure account on account of expenditure on a plywood partition erected	3270.00	
	3227.68	
Add: Provision during the year as per Income & Expenditure a/c	100000.00	103227.68
Carried over		742961.04

ASSETS

Immovable Properties:		Nil
Investments:		
Government Securities (At cost):		
3% Conversion Loan 1946/86 of the face value of Rs. 25000/- (market value)	25000.00	
$5\frac{1}{2}$% Government of India Loan 2000 of the face value of Rs. 2000/- (market value)	2000.00	
In Units of the Face Value of:		
Rs. 2,35.257.90 of the Unit Trust of India (under re-investment plan)	235818.23	
In Fixed Deposit with Maharashtra State Road Transport Corporation:	60000.00	322818.23
Motor Cars, Motor Cycles & Auto Cycles:		
Balance as per last Balance Sheet	1919.64	
Less: Depreciation during the year	383.91	1535.73
Furniture Fixture & Equipment:		
Balance as per last Balance Sheet	75989.79	
Add: Additions during the year	12973.75	
	88963.54	
Less: Depreciation during the year	11120.44	77843.10
Loans (Unsecured considered good):		
To Employees		2070.00
Carried over		404267.06

FUNDS AND LIABILITIES

Brought over		742961.04
Provision for Depreciation on Investment:		
Balance as per last Balance Sheet		9266.10
Publication Fund:		
Balance as per last Balance Sheet	235173.41	
Add: Grant received from US Dept of the Interior Fish & Wildlife Service transferred per Income & Expenditure account	643500.00	
Add: Sale proceeds of Glimpses of Nature booklet published under WWF/Volkart Foundation Grant	3237.05	881910.46
Other Earmarked Funds:		
As per Schedule 'A'		3312470.70
Staff Gratuity Fund:		
Balance as per last Balance Sheet	166800.00	
Add: Interest received during the year	16680.00	
Add: Provision during the year as per Income & Expenditure account	50000.00	233480.00
Provision for Capital Losses:		
Balance as per last Balance Sheet		15025.23
Centenary Celebration Fund:		
Balance as per last Balance Sheet	191846.45	
Less: Transferred to Income & Expenditure account on account of expenditure on ex-gratia payment to staff	85591.80	106254.65
Carried over		5301368.18

ASSETS

Brought over		404267.06
Advances (Unsecured considered good):		
To trustees (for expenses)	15000.00	
To employees (for project expenses)	144560.46	
To employees (for other Society's expenses)	2651.40	
To others	28217.21	
To Nature Education Scheme	6877.57	197306.64
Stocks:		
A) Publications as per inventory taken & certified by the Honorary Secretary	948580.41	
B) Safety cartridges as per inventory taken & certified by the Honorary Secretary	9530.35	
C) Cost of publications under preparation:		
1) Encyclopedia of Indian Natural History	135073.05	
2) A Century of Natural History	101940.00	
3) Book of Indian Reptiles	16116.50	
4) Book on trees (new)	3550.00	1214790.31
Income Outstanding:		
Interest accrued	51960.76	
Supplies & Services	82517.18	
Grant, Govt. of Maharashtra for '83-84	143386.40	
Grant, Govt. of India, Dept. of Science & Technology for Journal printing expenses	40000.00	
Carried over	317864.34	1816364.01

FUNDS AND LIABILITIES

Brought over		5301368.18
Herbarium Fund:		
Appropriation during the year as per Income & Expenditure account		25000.00
Hornbill Newsletter Fund:		
Appropriation during the year as per Income & Expenditure account		50000.00
Liabilities:		
For expenses	169163.32	
For Library Deposit	800.00	
For Sundry Credit Balances	4659.50	
For Advances for publications (under preparation)	42507.71	
For other advances (Amount received for & on behalf of the proposed institute)	238952.46	456082.99
Income & Expenditure Account:		
Balance as per last Balance Sheet	3790.91	
Less: Excess of expenditure over income transferred from Income & Expenditure account	458.91	3332.00
Carried over		5835783.17

ASSETS

Brought over		1816364.01
Income Outstanding (Contd.):		
Brought over	317864.34	
Grant, Govt. of India, Dept. of Environment for Centenary Seminar expenses	25000.00	
Grant, Indian National Science Academy for 1983-84 Journal printing expenses	5000.00	347864.34
Income Tax Refundable:		13264.40
Cash & Bank Balances:		
A) *In Current Account with*:		
1) Grindlays Bank Ltd., M. G. Road, Bombay	72930.37	
2) Grindlays Bank Ltd., London (£729.20 @ Rs. 16/-)	11667.20	
3) Chartered Bank, M. G. Road, Bombay	391174.05	
In Savings Account with:		
1) Grindlays Bank Ltd., M. G. Road, Bombay	42295.13	
2) Bank of India, Museum Savings Branch, M. G. Road, Bombay	18140.18	
3) Bank of Baroda, University Branch, M. G. Road, Bombay	508724.79	
4) Corporation Bank, Dalal Street, Bombay	869358.70	
B) *In Fixed Deposit with*:		
1) Bank of India, M. G. Road, Bombay consisting of Rs. 36000/- of Dr. Sálim Ali-Loke Wan Tho Ornithological Research Fund & Rs. 3000/- of Col. Burton's Nature Conservation Fund	114000.00	
Carried over	2028290.42	2177492.75

FUNDS AND LIABILITIES		ASSETS		
Brought over	5835783.17	Brought over		2177492.75
		Cash & Bank Balances (Contd.):		
		Brought over	2028290.42	
		2) Chartered Bank, M. G. Road, Bombay consisting of Rs. 200000/- of Dr. Sálim Ali-Loke Wan Tho Ornithological Research Fund	200000.00	
		3) Bank of Baroda, M. G. Road, Bombay	100000.00	
		4) Corporation Bank, Dalal Street, Bombay consisting of Rs. 40000/- of Pirojsha Godrej Foundation Fund & Rs. 200000/- of the proposed Institute of Natural History	400000.00	
		5) Grindlays Bank, M. G. Road, Bombay consisting of Rs. 32,566/- of Staff Welfare Fund & Rs. 45613/- of Charles McCann Vertebrate Zoology Field Work Fund	155000.00	
		6) In monthly income Certificates with Bank of India, M. G. Road, Bombay consisting of Rs. 618124/- of Dr. Sálim Ali Nature Conservation Fund	775000.00	3658290.42
Total	5835783.17	Total		5835783.17

H. K. Divekar,
Honorary Treasurer,
Bombay Natural History Society

A. N. D. Nanavati,
Honorary Secretary,
Bombay Natural History Society

As per our report of even date
Habib & Co.,
Chartered Accountants

Bombay, 22*nd November*, 1984.

SCHEDULE 'A'

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING THE PART OF BALANCE SHEET AS AT 31ST DECEMBER 1983

Name of the Fund/Grant (1)	*Balance as per last Balance Sheet* (2)	*Amount received/appropriated during the year* (3)	*Interest earned during the year* (4)	*Dr. balance* (5)	*Total of columns 2, 3, 4 & 5* (6)	*Spent during the year* (7)	*Refunds* (8)	*Total of columns 7 & 8* (9)	*Balance as at 31st December 1983 (6 minus 9)* (10)
(1) Staff Welfare Fund	29605.66	—	2960.56	—	32566.22	—	—	—	32566.22
(2) Sálim Ali-Loke Wan Tho Ornithological Research Fund	271136.52	50000.00	—	—	321136.52	—	—	—	321136.52
(3) Col. Burton's Nature Conservation Fund	3706.33	—	300.00	—	4006.33	605.30	—	605.30	3401.03
(4) Charles McCann Vertebrate Zoology Field Work Fund	41506.34	500.00	4150.63	—	46156.97	543.33	—	543.33	45613.64
(5) Sálim Ali Nature Conservation Fund	606124.80	12000.00	—	—	618124.80	—	—	—	618124.80
(6) Sálim Ali Nature Conservation Fund for Silent Valley expenses	11341.97	—	—	—	11341.97	—	—	—	11341.97
(7) Field Work Fund under Pirojsha Godrej Foundation	40000.00	—	—	—	40000.00	—	—	—	40000.00
(8) Hospitality Fund (Dr. Sálim Ali)	934.30	—	—	—	934.30	223.15	—	223.15	711.15
(9) Projector Fund received from members	968.04	—	—	—	968.04	—	—	—	968.04
(10) Scholarship Fund under Sálim Ali-Loke Wan Tho Ornithological Research Fund Investment	8523.19	—	32113.65	—	40636.84	31533.82	—	31533.82	9103.02
(11) Conservation Fund under Sálim Ali Nature Conservation Fund Investment	30893.76	—	61662.48	—	92556.24	48781.59	—	48781.59	43774.65
(12) Field Work Fund under Pirojsha Godrej Foundation Fund Investment	5741.58	—	4000.00	—	9741.58	7280.00	—	7280.00	2461.58
	1050482.49	62500.00	105187.32	—	1218169.81	88967.19	—	88967.19	1129202.62

Name of the Fund/Grant	Balance as per last Balance Sheet	Amount received/appropriated during the year	Interest earned during the year	Dr. balance	Total of columns 2, 3, 4 & 5	Spent during the year	Refunds	Total of columns 7 & 8	Balance as at 31st December 1983 (6 *minus* 9)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Brought over	1050482.49	62500.00	105187.32	—	1218169.81	88967.19	—	88967.19	1129202.62
(13) Field Work Fund Sir Dorabji Tata Trust	—	10000.00	—	—	10000.00	—	—	—	10000.00
(14) *Grant Govt. of Maharashtra*:									
a) Grant for 1982-83 for Establishment & Building maintenance	29790.51	—	—	—	29790.51	29790.51	—	29790.51	—
b) Grant for 1983-84 for Establishment & Building maintenance	—	139386.40	—	—	139386.40	104583.94	—	104583.94	34802.46
c) Grant for 1983-84 for Building Repairs	—	123000.00	—	—	123000.00	—	—	—	123000.00
(15) *Grant Govt. of India, Department of Science & Technology*:									
a) Grant for 1980-81 contd., 1981-82 contd., 1982-83 contd., 1983-84 for Bldg repairs	190229.03	—	—	—	190229.03	111781.47	—	111781.47	78447.56
b) Grant for 1980-81 contd., 1981-82 contd., 1982-83 contd., 1983-84 for Computer Analysing of Bird Banding Data	11413.56	—	—	—	11413.56	—	—	—	11413.56
(16) Grant for 1983-84 from Govt. of India, Dept. of Environment for the expenses on Secretarial assistance to Dr. Sálim Ali for environmental Research programme for processing of archival material	—	12300.00	—	1098.62	11398.62	13398.62	—	13398.62	—
	1281915.59	347186.40	105187.32	1098.62	1735387.93	348521.73	—	348521.73	1386866.20

Name of the Fund/Grant (1)	*Balance as per last Balance Sheet* (2)	*Amount received/appropriated during the year* (3)	*Interest earned during the year* (4)	*Dr. balance* (5)	*Total of columns 2, 3, 4 & 5* (6)	*Spent during the year* (7)	*Refunds* (8)	*Total of columns 7 & 8* (9)	*Balance as at 31st December 1983 (6 minus 9)* (10)
Brought over	1281915.59	347186.40	105187.32	1098.62	1735387.93	348521.73	—	348521.73	1386866.20
(17) Grant Govt. of India, Ministry of Defence, Aeronautics Research & Development Board for An Ecological Study of Bird Hazards at Indian Aerodromes	885662.56	906000.00	—	—	1791662.56	553077.27	71732.22	624809.49	1166853.07
(18) Grants from US Dept. of the Interior Fish & Wild Life Service-National Park									
1) Studies on the movement & population structure	82319.68	463510.00	—	—	545829.68	518226.64	—	518226.64	27603.04
2) Hydrobiological (Ecological) Research Station at Keoladeo Ghana Sanctuary, Bharatpur	568659.26	387700.00	—	—	956359.26	537167.17	—	537167.17	419192.09
3) Study of Ecology of Certain Endangered Species of Wildlife and and their habitats	8732.79	648810.00	—	—	657542.79	390566.65	—	390566.65	266976.14
(19) Grant from Chief Wildlife Warden, Chandigarh, Punjab for Bird Ringing Projects	18449.78	42617.00	—	—	61066.78	16086.62	—	16086.62	44980.16
Total	2845739.66	2795823.40	105187.32	1098.62	5747849.00	2363646.08	71732.22	2435378.30	3312470.70

Regd. No. F. 244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

BOMBAY PUBLIC TRUSTS ACT, 1950

SCHEDULE IX VIDE RULE 17(1)

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST DECEMBER 1983

EXPENDITURE

To *Expenses in respect of Properties*:		
Rates & Taxes:		
Met out of grant Govt. of Maharashtra 1983-84		4779.00
,, *Repairs & Maintenance*:		
a) Met out of Grant, Govt. of India, Dept. of Science & Technology 1980-81, contd. 1982-83, contd. 1983-84 as per contra.	111781.47	
b) Met out of Building Fund as per contra	3270.00	
c) Others	179.80	115231.27
Insurance:		323.00
,, *Other Expenses*:		
Met out of Grant of Govt. of Maharashtra 1983-84	3221.00	
Others	15512.20	18733.20
,, *Establishment expenses*:		
Salaries including D.A. etc. (as per contra) from Govt. of Maharashtra grant for 1982-83	29790.51	
for 1983-84	96583.94	
Salaries including D.A. etc. (other than above)	274327.90	
Carried over	400702.35	139066.47

INCOME

By *Rent* (Accrued & realised):		
,, *Interest* (Accrued & realised):		
On Securities	860.00	
On Fixed Deposits & Bank Accounts	209889.98	210749.98
,, *Dividend*:		
On Units of the Unit Trust of India	27346.23	
Less: Accounted in the earlier year	13414.00	13932.23
,, *Donations* (in cash or kind):		
Centenary Celebration Donation	207011.42	
Centenary Photographic Exhibition Donations	45000.00	
Other general donations (in cash)	25819.60	277831.02
,, *Donations towards specific purpose*:		
Charles McCann Vertebrate Zoology Fieldwork Fund	500.00	
Sálim Ali Nature Conservation Fund	12000.00	
Sir Dorabji Tata Trust Field Work Fund	10000.00	
Sálim Ali-Loke Wan Tho Ornithological Research Fund from Sir Dorabji Tata Trust	50000.00	72500.00
Life membership fees individual	65579.85	
Corporate life membership fees	115461.31	181041.16
Carried over		756054.39

EXPENDITURE

Brought over		139066.47
To *Establishment expenses* (Contd.):		
Brought over	400702.35	
Society's contribution to Staff Provident Fund	13305.00	
Postages	10994.50	
Printing & Stationery	26896.85	
Advertisement	1307.00	
Telephone rental & call charges	5259.30	
Meeting expenses including talks, films etc.	4451.45	
Conveyance & travelling expenses (local)	2982.25	
Ex-gratia payment to staff members	85591.80	
Bank charges	1363.12	
Medical expenses for staff members	8976.75	
Leave travel expenses to staff members	1787.40	563617.77
,, *Audit Fees*:		1000.00
,, *Amount Written off*:		
Bad Debts		993.55
,, *Miscellaneous expenses*:		
General charges	9423.05	
Insurance premium	232.00	
Exchange fluctuation	1802.20	
Repairs to furniture & equipments	10312.55	
Members' Room Renovation	20000.00	
Garden maintenance & other expenses	13450.00	
Legal fees	525.00	55744.80
,, *Depreciation*:		
On furniture and equipment	11120.44	
On motor cars, motor cycle & auto cycle	383.91	11504.35
Carried over		771926.94

INCOME

Brought over		756054.39
By *Grants*:		
A) *Govt. of Maharashtra*:		
1) For 1983-84 Establishment & Building Maintenance	139386.40	
2) 1983-84 Educational activity (Journal printing)	4000.00	
3) For 1983-84 for repairs to the building (Hornbill House)	123000.00	
4) 1983-84 for the Centenary Seminar Expenses	10000.00	
B) *Govt. of India*:		
1) Department of Science & Technology for 1983-84 for Journal printing expenses	40000.00	
2) Dept. of Environment for 1983-84 for the Centenary Seminar expenses	25000.00	
3) Dept. of Environment for Dr. Salim Ali's Secretarial Assistance for processing of the archival material for environmental programme	12300.00	
4) National Council of Educational Research & Training, Dept. of Education in Science & Mathematics for Centenary Seminar expenses during 1983-84	90000.00	
C) *Indian National Science Academy* For 1973-84 Journal printing expenses	5000.00	
D) *Chief Wildlife Warden, Chandigarh Punjab* For 1983-84 Bird Ringing Project	42617.00	
Carried over	491303.40	756054.39

Expenditure

Brought over			771926.94
,, *Centenary Celebrations*:			
Celebrations of Centenary (Programmes)		42184.51	
Audio Visual		36549.20	
Seminar expenses		194165.37	
Photographic exhibition		43661.93	
Snake Exhibition expenses		369861.50	686422.51
To *Amounts transferred to reserve or Specific Funds*:			
Grants transferred to relevant funds		2723323.40	
Donations towards specific funds transferred to relevant account in the Balance Sheet		72500.00	
Life membership fees transferred to life membership fund in the Balance Sheet		65579.85	
Corporate life membership fees transferred to Corporate Life Membership Fund in the Balance Sheet		115461.31	
,, *Transfer to Publication Fund*:			
Sale proceeds of Glimpses of Nature Booklet	3237.05		
Grant from US Dept of the Interior Fish & Wildlife Service for the publication of Pictorial Guide to the Birds of Indian Sub-continent	643500.00	646737.05	
Interest on Fixed Deposits transferred to respective funds		141867.32	3765468.93
Carried over			1458349.45

Income

Brought over		756054.39
By *Grants* (Contd.):		
Brought over	491303.40	
E) *US Dept. of the Interior Fish & Wildlife Service — National Park*		
1) For Studies on Movement & Population Structure of Indian Avifauna	463510.00	
2) For Hydrobiological (Ecological) Research Station at Keoladeo Ghana Bird Sanctuary, Bharatpur	387700.00	
3) For the Study of Ecology of Certain Endangered Species of Wildlife & their habitats	648810.00	
4) For the publication of Pictorial Guide to the Birds of Indian Sub-continent by Dr. Salim Ali & Dr. S. Dillon Ripley	643500.00	
F) *Grant from Govt. of India*: Ministry of Defence AR & DB for An Ecological Study of Bird Hazards at Indian Aerodromes 1983-84	906000.00	3540823.40
Income from Subscriptions & Entrance Fees:		
Membership subscriptions (individual)	96602.78	
Corporate membership subscriptions	22878.40	
Student membership subscription	2950.00	
Subscriptions to Journal (non-members)	19185.41	
Entrance fees	17710.00	159326.59
,, *Income from Publications*:		
Journal sales	465.00	
Glimpses of Nature booklet	3237.05	3702.05
Carried over		4459906.43

EXPENDITURE		
Brought over		1458349.45
,, *Provisions/Appropriations to Specific Funds*:		
For Staff Gratuity Fund	50000.00	
For Herbarium Fund	25000.00	
For Building Maintenance Fund	100000.00	
For Hornbill Newsletter Fund	50000.00	225000.00
,, *Expenses on Objects of the Trust*: *Educational*: from respective funds (as per contra)		
1. Expenses towards research scholarships & other expenses on ornithological research out of scholarship fund under Sálim Ali-Loke Wan Tho Ornithological Research Fund	31533.82	
2. Expenses from the interest on Sálim Ali Nature Conservation Fund (including Rs. 15000/- for the publication of Hornbill Newsletter)	48781.59	
3. Expenses for field research under interest on Pirojsha Godrej Foundation Fund Investment (including Rs. 5000/- on Nisarg Yatra)	7280.00	
4. Expenses under Charles McCann Vertebrate Zoology Field Work Fund	543.33	
5. An Ecological Study of Bird Hazards at Indian Aerodromes met out of grant received from Aeronautical Research & Development Board, Govt. of India Ministry of Defence	553077.27	
Carried over	641216.01	544881.38

INCOME		
Brought over		4459906.43
By *Income from Subscriptions & Entrance Fees* (Contd.):		
,, *Surplus on Sale of Books*:		
Book of Indian Birds	43729.00	
Book of Indian Animals	21292.00	
Some Beautiful Indian Trees	4814.00	
Some Beautiful Indian Climbers & Shrubs	5876.60	
Identification of Poisonous Snake Charts	135.00	
Synopsis of the Birds of India & Pakistan	3428.00	
Grasses of Western India	1940.00	
Butterflies of the Indian Region	2330.50	
Hornbill stickers	925.00	
Pictorial Guide to the Birds of Indian Sub-continent	1669.31	
Other publications	11268.70	
Nature calendars & greeting cards	25716.25	
Surplus on packing & forwarding charges	345.07	123469.43
,, *Miscellaneous Income*:		
Miscellaneous receipts	3698.59	
Nature Camp surplus	244.00	
Advertisement fees on Nisarg Yatra	19100.00	
Fees for Photographic Exhibition competition	1684.00	
Delegation & Seminar fees for Centenary Seminar	67915.00	92641.59
Receipts from Snake Exhibition		405472.00
,, *Administrative Fees*:		
For handling various funds during the year debited to respective funds		216465.07
,, *Expenses Transferred to Specific Funds*: (As per contra)		
Expenses transferred to Building Fund	3270.00	
Carried over	3270.00	5297954.52

EXPENDITURE

Brought over		5448818.38
To *Expenses on Objects of the Trust* (Contd.):		
Brought over	641216.01	
6. Studies on Movement & Population Structure of Indian Avifauna, met out of grant US Dept of the Interior, Fish & Wildlife Service-National Park Service	518226.64	
7. Hydrobiological (Ecological) Research Station, Keoladeo Ghana Sanctuary, Bharatpur, met out of grant US Dept of the Interior, Fish & Wildlife Service — National Park Service	537167.17	
8. Expenses for the study of Ecology of Certain Endangered Species of Wildlife & their habitats met out of grant US Dept of Interior Fish & Wildlife Service — National Park Service	390566.65	
9. Expenses under Col Burton's Nature Conservation Fund	605.30	
10. Expenses for Bird Ringing Project met out of grant from Chief Wildlife Warden, Chandigarh, Punjab	16086.62	
11. Expenses met out of Dr Sálim Ali's Hospitality Fund	223.15	
12. Expenses on Secretarial Assistance to Dr. Sálim Ali for Environmental Research Programme for processing of Archival material met out of grant from Govt. of India. Dept. of Environment	13398.62	2117490.16
" *Expenses on Objects*: (other than those met out of specific funds)		
Nisarg Yatra expenses	18761.95	
Carried over	18761.95	7566308.54

INCOME

Brought over		5297954.52
By *Expenses transferred to specific funds* (Contd.):		
Brought over	3270.00	
Depreciation on Fixed Assets transferred to fixed assets fund	11504.35	
Expenses on establishment & building maintenance transferred to Govt. of Maharashtra grant for 1982-83	29790.51	
1983-84	104583.94	
Expenses on building repairs transferred to Grant, Govt. of India,, Dept. of Science & Technology Contd. 1982-83, contd. 1983-84	111781.47	
Expenses on specific objects transferred to relevant funds/grants (as per contra)	2117490.16	
Transfer from Centenary Celebration Fund for the expenditure on ex-gratia payment to staff members during 1983	85591.80	2464012.23
Excess of expenditure over income transferred to Balance Sheet		458.91
Carried over		7762425.66

Expenditure				Income	
Brought over			7566308.54		
To *Expenses on Objects* (Contd.):				Brought over	7762425.66
Brought over		18761.95			
,, *Journal Expenses*:					
1. For publishing the Journal of the Society	124750.30				
2. For publishing Hornbill Newsletter	32832.06	157582.36			
,, *Library Account*:					
1. Subscriptions to other Societies	2153.21				
2. Purchase of books	3552.55				
3. Book binding charges	2234.60	7940.36			
,, *Field Study Programme & Other Local Field Study Expenses*:		5215.55			
,, *Maintenance of Reference Collections*:		6616.90	196117.12		
Total			7762425.66	Total	7762425.66

H. K. Divekar,
Honorary Treasurer,
Bombay Natural History Society

A. N. D. Nanavati,
Honorary Secretary,
Bombay Natural History Society

As per our report of even date
Habib & Co.,
Chartered Accountants

Bombay, 22*nd November*, 1984.

BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED 31*ST DECEMBER*, 1983

RECEIPTS			PAYMENTS		
To *Balance as at* 1*st January* 1983			By Refund of Advances from Bombay Natural History Society		7842.57
1) With Grindlays Bank, Bombay on Current account.	3967.54		„ Salary Nature Education Organiser		19045.45
2) With Nature Education Organiser	200.00	4167.54	„ Postages		360.75
			„ Printing and Stationery		1013.65
„ *Grants*:			„ General Charges		2134.40
Government of Maharashtra for the year 1982-83		19738.20	„ *Balance as at* 31*st December* 1983		
„ *Sale of Nature Study Booklets*		965.00	1) With Grindlays, Bombay (in current account)	1151.49	
Advance from Bombay Natural History Society		6877.57	2. Cash on hand with Nature Education Organiser	200.00	1351.49
Total		31748.31	Total		31748.31

H. K. DIVEKAR,
Honorary Treasurer,
Bombay Natural History Society

A. N. D. NANAVATI,
Honorary Secretary,
Bombay Natural History Society

As per our report of even date
HABIB & CO.,
Chartered Accountants

BOMBAY, 22*nd November*, 1984.

BOMBAY NATURAL HISTORY SOCIETY

THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY WAS HELD ON THURSDAY, THE 20TH DECEMBER 1984, AT HORNBILL HOUSE AT 6-30 P.M. WHEN THE FOLLOWING MEMBERS WERE PRESENT:

(Seventy three members were present: The names will be listed when the minutes are published — Curator).

1. Dr. C. V. Kulkarni (in the chair)
2. Dr. Sálim Ali
3. Mr. Bharat Bhushan
4. Ms. Heta Pandit
5. Prof. P. V. Bole
6. Mr. R. A. Gadiyar
7. Mr. D. J. Panday
8. Mr. Adhik Shirodkar
9. Mr. A. E. Medhora
10. Mr. S. P. Kamath
11. Mr. P. V. Kale
12. Mr. Humayun Abdulali
13. Mr. M. R. Almeida
14. Mr. D. N. Goenka
15. Ms. Archna Mehrotra
16. Mr. A. B. Pathak
17. Mr. A. K. Joshee
18. Mr. J. C. Daniel
19. Dr. (Mrs.) S. Unnithan
20. Mr. N. C. Chhaya
21. Mr. J. P. Irani
22. Ms. M. M. Haribal
23. Mr. Bittu Sahgal
24. Sanctuary Magazine
25. Mr. V. K. Paralkar
26. Mr. V. James
27. Mr. Shahid Ali
28. Mr. Sunil Zaveri
29. Mr. Premchand T. Dabrai
30. Mrs. Dilnavaz Variava
31. Mr. V. Narayanaswami
32. Prince of Wales Museum (S. P. Fondekar)
33. Mr. M. D. Agharkar
34. Mr. H. K. Divekar
35. Mrs. Panna Raiji
36. Mr. V. N. Raiji
37. Mr. D. P. Bannerjee
38. Dr. A. N. D. Nanavati
39. Mr. D. S. Gaitonde
40. Mr. Galden Lachungpa
41. Ms. Arati Kaikini
42. Mr. Ulhas Rane
43. Mrs. Usha Lachungpa
44. Mr. N. D. Mulla
45. Mrs. Savitri Sivaram
46. Mr. S. R. Nayak
47. Cdr. G. V. K. Unnithan
48. Mr. A. L. Hegde
49. Mr. G. B. Nadkarni
50. Mr. S. N. Mistry
51. Mr. Nitin Jamdar
52. Ms. P. S. Patale
53. Mr. R. Reuben
54. Mr. Suresh Sali
55. Mr. Shyam Chainani
56. Dr. Robert Grubh
57. Mr. S. A. Hussain
58. Mr. M. K. Mistry
59. Mr. S. R. Paradkar
60. Mr. S. S. Malkani
61. Mr. G. L. Kalro
62. Mr. Ram Jethmalani
63. Mr. K. Hanumantha Rao

64. Mr. G. C. Patel
65. Mr. S. D. Bhaumik
66. Mr. S. A. Ruparel
67. Mr. B. P. Sanghavi
68. Mr. Suresh Bhatkal
69. Mr. Mahendra Velinkar
70. Mr. A. V. Ghangurde
71. Mr. K. N. Naoroji
72. Mr. Kiran Srivastava
73. Dr. J. H. Thakkar

The President, Dr. Sálim Ali, requested Dr. C. V. Kulkarni, Vice President of the Society to conduct the meeting on his behalf.

Dr. C. V. Kulkarni referred to the condolence resoluiton on the death of the Society's Patron, Smt. Indira Gandhi which had been passed at a Special Meeting of members and later forwarded to Mr. Rajiv Gandhi.

1. The Honorary Secretary hoped that members had collected the cyclostyled copies of the report for 1983. He drew attention to certain salient features such as the doubling of the membership in the last 5 years, various publications that had been either published or were under preparation and the recognition of the Society by the University Grants Commission for financial aid and the continued recognition of the Society by the University of Bombay for research under various disciplines of biology.

The Honorary Secretary stated that the field projects being operated by the Society had received particular appreciation on the quality of the work done under the projects. He read out a letter from the Chief of the Air Staff, thanking the Society for its investigations of Bird Hazards to aircraft and the recommendations arising thereof. He also read a letter from the Secretary, Department of Ocean Development, Govt. of India, congratulating the Principal Investigator and his colleagues on the scientific contributions made by the project on hydrobiology at Bharatpur and read a letter from the Secretary, Forests, Govt. of Tamil Nadu appreciating the work done by the Society at Point Calimere area under the Avifauna Project. He also drew attention to the faet that the projects had been useful in realising funds for the operation of the Society's activities.

The report was then discussed. Mr. N. C. Chhaya suggested that the Annual Report of the Society be made available to members at least 15 days in advance of the scheduled Annual General Meeting in the future. It was agreed that efforts would be made to do so.

Mr. Humayun Abdulali stated that he was not satisfied with the purchase of a computer for the Bird Hazard Project nor with the quality of the work turned out by the projects and also stated that he had written a critical report on a paper published by one of the projects' scientific staff and that it had been referred to the editors by the Executive Committee for consideration several months ago. At the instance of the Chairman, the Curator stated in reply that the computer had been purchased after due consideration of the requisite number of quotations from various manufacturers and the equipment had been examined and approved by Dr. Sadanandan, Systems Manager at the Tata Institute of Fundamental Research. The computer was a necessary equipment for analysing the data collected by Bird Hazard Project, which in accordance with instruetions from the Aeronautics Research & Development Board of Ministry of Defence has to be considered as classified. The Curator stated that evidenee of the quality of the work by the projects was available from the letters of appreciation received from knowledgeable persons which had been read out by the Honorary Secretary and that

it was not necessary for him to speak on this matter. As regards Mr. Abdulali's paper the Editors were considering it for publication and an edited version will be published after its approval by the author.

Thereafter Dr. A. K. Joshi proposed acceptance of the report and the proposal was seconded by Mr. Gaitonde and the report accepted unanimously by the general body.

2. The Chairman then requested the Honorary Treasurer to present the accounts for 1983. Arising out of the discussion on the accounts Mr. Humayun Abdulali drew attention to the purchase of a computer at a cost of Rs. 1,40,000 and stated that as far as he was aware that the expenditure had not been made with the sanction of the Committee. The Honorary Treasurer stated that there was a budget allotment of 4 lacs for equipment and the budget estimate for the project had been approved by the Executive Committee when they passed the project document. Mr. Humayun Abdulali drew attention to the fact that the Honorary Treasurer had often made expenditure over the limit of Rs. 1,000 as prescribed in Rule 55 of the Rules and Regulations of the Society. The general consensus at the Executive Committee meeting was that the prescribed limit of expenditure which was laid down when the rule was formulated in 1926 required to be increased considerably because of increase in costs and that the revision should be done along with the revision of the other rules of the Society. Mr. D. N. Goenka sought details of the outstanding items in the accounts which amounted to Rs. 14,000. The Honorary Treasurer explained that the majority of the outstanding amounts related to unpaid bills of members and others on supplies of items such as calendars and that every effort is being made to realise these amounts and that he was confident of recovering most of the outstanding dues. Other outstanding amounts are from imprest accounts and are recouped from time to time. Mr. Goenka also wished to have information on whether estimates had been called for towards expenditure on the setting up of the Members' Room. Mr. Bittu Sehgal, who had organised this activity, advised that the architect's original estimate was for Rs. 2 lacs and all other estimates that he had received were in excess of a lac. The present contract was originally for Rs. 28,000 but the final payment was only Rs. 20,000. The Honorary Secretary informed that Mr. Sahgal had in addition incurred a personal expenditure to the extent of Rs. 10,000 in the same connection and the Society was grateful to him for this assistance.

Mr. Goenka and other members suggested that the amounts now invested in fixed deposits be invested in debentures and other high interest investments with the Charity Commissioner's permission.

Some members drew attention of the general body to the fact that there would not be any objection from the Charity Commissioner to investing 50% of such amounts in deposits other than with banks. A suggestion was also made to the Executive Committee to examine the question of converting the Society's funds in sterling in England into another stable currency as the value of Pound is fast deteriorating. Mrs. Variava explained that a Finance Committee was being appointed to examine such points.

The question of the return of funds to the Defence Department was raised Mr. Goenka and the Honorary Treasurer advised that this return was the refund of amounts that could not be utilised during the financial year in which they were sanctioned and which according to Govt. regulations should be returned to government as unspent balance at the end

of the financial year. He further stated that additional details about the accounts could not be given as it was a defence oriented project.

The accounts were than put up for approval. Dr. A. N. D. Nanavati proposed the acceptance of the accounts which was seconded by Mr. V. Narayana Swami. The accounts were unanimously adopted.

3. The Chairman advised that the proceedings of the Annual General Meeting held in November 1983 had been questioned regarding the amendments to Rule 29 and 30. As recorded 50 signatories would be required for calling an Sxtraordinary General Meeting.

However opinions had been expressed that the final agreed figure was 25 and not 50. Mr. D. J. Panday, who had chaired the 1983 Annual General Meeting felt that at this point of time he was regretfully unable to confirm or revise the figures in dispute.

Many of the members present maintained that resolutions changing the rules should not be placed for discussion on the floor of any Annual General Meeting without being circulated to all members earlier, as an Agenda item. As the above item had not been circulated according to Rules, the resolution was therefore considered invalid.

It was then proposed by the Chairman and agreed to by those present that the resolution could be reconsidered at the revision of the current rules of the Society which was under consideration.

Mr. Goenka and Mr. Rane had suggested independently several amendments to the existing rules. The Executive Committee also had considered several amendments necessary. The General Body, therefore, was of the opinion that the rules and regulations of the Society should be examined carefully and revised and that it would be necessary to have a special general body meeting to consider such a revision. It was agreed that the suggestions made by Mr. D. N. Goenka and Mr. Ulhas Rane and also opinions of other members be circulated to all members of the Society well in advance and a Special Meeting of the General Body be called in six months time to consider adopting the revised rules.

The meeting terminated with a vote of thanks to the Chair.